Spectrum DE

TK 51298-2-MM (Rev. 3, 11/04)

The maintenance information in this manual covers unit models:

Spectrum DE 30-2 (002217) System Spectrum DE 30-2 (900026)

Spectrum DE 30-3 (002216) System Spectrum DE 30-3 (900025)

For further information, refer to:

Spectrum DE Operator's Manual	**TK 51299**
Spectrum DE Parts Manual	**TK 51310**
ThermoGuard µP-IV Multi-Temp Microprocessor Controller Diagnosis Manual	**TK 50033**
TK486 Engine Overhaul Manual	**TK 50136**
X214, X418, X426, and X430 Compressor Overhaul Manual	**TK 6875**
Diagnosing TK Refrigeration System	**TK 5984**
Tool Catalog	**TK 5955**
Evacuation Station Operation and Field Application	**TK 40612**
ElectroStatic Discharge (ESD) Training Guide	**TK 40282**
TC Trailer Unit Refrigeration Systems Identification, Training, and Diagnostic Guide	**TK 40660**

The information in this manual is provided to assist owners, operators and service people in the proper upkeep and maintenance of Thermo King units.

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Recover Refrigerant

At Thermo King, we recognize the need to preserve the environment and limit the potential harm to the ozone layer that can result from allowing refrigerant to escape into the atmosphere.

We strictly adhere to a policy that promotes the recovery and limits the loss of refrigerant into the atmosphere.

In addition, service personnel must be aware of Federal regulations concerning the use of refrigerants and the certification of technicians. For additional information on regulations and technician certification programs, contact your local Thermo King dealer.

R-404A

WARNING: Use only Polyol Ester-based refrigeration compressor oil in R-404A. See Thermo King Parts Manual for part number.

Do not mix Polyol Ester and standard synthetic compressor oils. Keep Polyol Ester compressor oil in tightly sealed containers. If Polyol Ester oil becomes contaminated with moisture or standard oils, dispose of properly–DO NOT USE.

When servicing Thermo King R-404A unit, use only those service tools certified for and dedicated to R-404A refrigerant and Polyol Ester compressor oils. Residual non-HFC refrigerants or oils will contaminate R-404A systems.

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Safety Precautions

General Practices

1. *Always wear goggles or safety glasses.* Refrigerant liquid and battery acid can permanently damage the eyes. See First Aid under Refrigeration Oil.
2. Never operate the unit with the compressor discharge valve closed.
3. Keep your hands clear of the fans and belts when the unit is running. This should also be considered when opening and closing the compressor service valves.
4. Make sure the gauge manifold hoses are in good condition. Never let them come in contact with a belt, fan motor pulley, or any hot surface.
5. Never apply heat to a sealed refrigeration system or container.
6. Fluorocarbon refrigerants, in the presence of an open flame or electrical short, produce toxic gases that are severe respiratory irritants capable of causing death.
7. Make sure all mounting bolts are tight and are the correct length for their particular application.
8. Use extreme caution when drilling holes in the unit. The holes may weaken structural components. Holes drilled into electrical wiring can cause fire or explosion.
9. Use caution when working around exposed coil fins. The fins can cause painful lacerations.
10. Use caution when working with a refrigerant or refrigeration system in any enclosed or confined area with a limited air supply (for example, a bus or garage). Refrigerant tends to displace air and can cause oxygen depletion, resulting in suffocation.
11. EPA Section 608 Certification is needed to work on refrigeration systems.

Refrigerant

Although fluorocarbon refrigerants are classified as safe refrigerants, certain precautions must be observed when handling them or servicing a unit in which they are used. When exposed to the atmosphere in the liquid state, fluorocarbon refrigerants evaporate rapidly, freezing anything they contact.

First Aid: In the event of frost bite, the objectives of First Aid are to protect the frozen area from further injury, to warm the affected area rapidly, and to maintain respiration.

- *Eyes:* For contact with liquid, immediately flush eyes with large amounts of water and get prompt medical attention.
- *Skin:* Flush area with large amounts of lukewarm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection/injury. Get medical attention. Wash contaminated clothing before reuse.
- *Inhalation:* Move victim to fresh air and use CPR or mouth-to-mouth ventilation, if necessary. Stay with victim until arrival of emergency medical personnel.

Refrigerant Oil

Avoid refrigeration oil contact with the eyes. Avoid prolonged or repeated contact of refrigeration oil with skin or clothing. Wash thoroughly after handling refrigeration oil to prevent irritation.

First Aid: In case of eye contact, immediately flush with plenty of water for at least 15 minutes. *Call a physician.* Wash skin with soap and water.

Specifications

Engine

Model	TK 486
Number of Cylinders	4
Cylinder Arrangement	In-line vertical, number 1 on flywheel end
Firing Order	1-3-4-2
Direction of Rotation	Counterclockwise viewed from flywheel end
Fuel Type	No. 2 diesel fuel under normal conditions No. 1 diesel fuel is acceptable cold weather fuel
Oil Capacity: Crankcase	13 qt. (12.3 liters) crankcase
	Fill to full mark on dipstick
Oil Type	API Classification CI-4 or better (ACEA Rating E3 or better for Europe)
Oil Viscosity	5 to 122 F (-150 to 50 C): SAE 15W-40 -13 to 104 F (-25 to 50 C): SAE 10W-40 -13 to 86 F (-25 to 30 C): SAE 10W-30 -22 to 32 F (-30 to 0 C): SAE 5W-30
Engine rpm: Low Speed Operation	1450 ± 25 rpm
High Speed Operation	2200 ± 25 rpm
Engine Oil Pressure	18 psi (127 kPa) minimum in low speed 45 to 57 psi (310 to 390 kPa) in high speed
Intake Valve Clearance	0.006 to 0.010 in. (0.15 to 0.25 mm)
Exhaust Valve Clearance	0.006 to 0.010 in. (0.15 to 0.25 mm)
Valve Setting Temperature	70 F (21 C)
Fuel Injection Timing	10° BTDC (timed on No. 1 cylinder)
Low Oil Pressure Switch (Normally Closed)	17 ± 3 psi (117 ± 21 kPa)
Engine Coolant Thermostat	180 F (82 C)
Coolant System Capacity	7.5 qt (7.1 liters)
Radiator Cap Pressure	7 psi (48 kPa)
Engine Coolant Type	ELC (Extended Life Coolant), which is Red. Use a 50/50 concentration of any of the following equivalents: Chevron Dex-Cool Texaco ELC Havoline Dex-Cool® Havoline XLC for Europe Shell Dexcool® Shell Rotella Saturn/General Motors Dex-Cool® Caterpillar ELC Detroit Diesel POWERCOOL® Plus ***CAUTION: Do not add "Green" or "Blue-Green" conventional coolant to cooling systems using "Red" Extended Life Coolant, except in an emergency. If conventional coolant is added to Extended Life Coolant, the coolant must be changed after 2 years instead of 5 years.***
Coolant System Capacity	7.5 quarts (7.1 liters)
Drive	Direct to compressor; belts to fans, alternator, and water pump

Belt Tension

	Tension No. on TK Gauge P/N 204-427
Alternator Belt	67
Lower Fan Belt (Engine to Idler)	67
Upper Fan Belt (Fan to Idler)	74

Refrigeration System

Compressor		Thermo King X430L
Refrigerant Charge—Type		R-404A
Compressor Oil Charge:	4-Quart Sump*	4.3 qt (4.1 liters)**
	7-Quart Sump*	6.9 qt (6.6 liters)**
Compressor Oil Type		Polyol Ester type (refer to Tool Catalog)
Throttling Valve Setting		23 to 25 psi (159 to 172 kPa)
Heat/Defrost Method		Hot gas
High Pressure Cutout		470 ± 7 psi (3241 ± 48 kPa)
		Automatic reset @ 375 ± 38 psi (2586 ± 262 kPa)
High Pressure Control Switch:	Opens	300 +25/-0 psi (2068 +172/-0 kPa)
	Closes	200 ± 20 psi (1379 ± 138 kPa)

* See “Compressor Sump Sizes” on page 73 to determine the sump size.

** When the compressor is removed from the unit, oil level should be noted or the oil removed from the compressor should be measured so that the same amount of oil can be added before placing the replacement compressor in the unit.

Electrical Control System

Voltage	12.5 Vdc
Battery	One, group C31, 12 volt battery
Circuit Breaker CB1—Zone 3 Fan Motors	30 amp, auto reset
Fuse Link Rating	110 amps @ 72 F (22 C)
Fuse F2—Electric Contactors	5 amp
Fuse F3—Zone 1 Damper	15 amp
Fuse F4—High Speed (Throttle) Solenoid	15 amp
Fuse F6—Zone 1 (Host) Solenoids	15 amp
Fuse F12—Zone 3 Fan Motors	25 amp
Fuse F13—Zone 3 Solenoids	15 amp
Fuse F15—Zone 2 Damper	25 amp
Fuse F16—Zone 2 Solenoids	15 amp
Fuse F20—Control Circuit Power	40 amp
Fuse F22—Host Unit Controls	25 amp
Fuse F23—Starter Circuit	40 amp
Other Fuses	2 or 5 amp
Battery Charging	12 volt, 120 amp, brush type alternator
Voltage Regulator Setting	14.0 ± 0.2 volts @ 77 F (25 C)

NOTE: Fuse F7 (Bypass resistor for Prestolite Alternator) must be removed for the Bosch Alternator. The Bosch alternator has the word “BOSCH” on the end opposite the pulley (see Figure 17 on page 43).

Electrical Components

NOTE: Disconnect components from unit circuit to check resistance.			
		Current Draw (Amps) at 12.5 Vdc	**Resistance—Cold (Ohms)**
Fuel Solenoid:	Pull-in Coil	35 to 45	0.2 to 0.3
	Hold-in Coil	0.5	24 to 29
Damper Solenoids (Each)		5.7	2.2
High Speed (Throttle) Solenoid		2.9	4.3
Condenser Inlet Solenoid		1.3	9.6
Liquid Line Solenoids in Host Unit		1.5	8.3
Liquid Line Solenoid in Remote Unit		1.3	9.6
Hot Gas Solenoids		1.5	8.3
Suction Line Solenoids		1.3	9.6
Receiver Tank Pressure Solenoid		0.7	17.0
Purge Valve		0.7	17.0
Air Heater		70.0-89.0	.14
Starter Motor—Gear Reduction Type		250-375*	

*On-the-engine cranking check. Bench test is approximately 100 amps on the direct drive starter and approximately 80 amps on the gear reduction starter.

Smart Reefer Multi-Temp µP-IV Microprocessor Temperature Controller

Temperature Controller		Electronic Smart Reefer® Multi-Temp µP-IV Microprocessor with digital thermostat, thermometer and fault indicator monitor
Setpoint Range		Factory default setting -20 to 80 F (-29 to 27 C) Programmable setpoint range -25 to 90 F (-32 to 32 C)
Digital Temperature Display		-40 to 99.9 F (-40 to 40 C)
Internal Defrost Timer:	Temperature Pulldown	2, 4, 6, 8 or 12 hours (selectable, standard setting 4)
	Temperature In-range	4, 6, 8 or 12 hours (selectable, standard setting 6)
Defrost Initiation		Coil must be below 45 F (7.2 C)
Defrost Termination		Terminates defrost with coil temperature above 57 F (14 C)
Defrost Interval Timer		Terminates defrost 30 to 45 minutes (programmable) after initiation if coil sensor has not terminated defrost

Maintenance Inspection Schedule

Host Unit

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Microprocessor
•				Run Pretrip Test (refer to Pretrip Test in the Operator's Manual).
				Engine
•				Check fuel supply.
•				Check engine oil level.
•	•	•	•	Inspect belts for condition and proper tension (belt tension tool P/N 204-427).
•	•	•	•	Check engine oil pressure hot, on high speed (should display "OK").
•	•	•	•	Listen for unusual noises, vibrations, etc.
•		•		Check air cleaner restriction indicator (change filter when indicator reaches 25 in.). Replace EMI 3000 air cleaner element (see "EMI 3000 Air Cleaner" on page 66) at 3,000 hours or two years (whichever occurs first) if indicator has not reached 25 in.
	•	•	•	Drain water from fuel tank and check vent.
	•	•	•	Inspect/clean fuel transfer pump inlet strainer (prefilter).
	•	•	•	Check and adjust engine speeds (high and low speed).
	•	•	•	Check condition of drive coupling bushings per Service Bulletin T&T 171.
			•	Check condition of engine mounts.
	•	•	•	Replace standard (silver) fuel filter/water separator.
		•		Replace EMI 3000 (black) fuel filter/water separator.
				Engine Oil Change Intervals (see below) ***NOTE: The engine oil change interval is extended to 3,000 hours when equipped with the EMI 3000 oil filter and oil with API Rating CI-4 or better (ACEA Rating E3 for Europe). EMI 3000 filters are black with gold lettering.*** ***NOTE: Change engine oil and filter (hot).***
	•	•	•	Standard blue (or silver) oil filter.
		•		EMI 3,000 (black) oil filter. Requires oil with API Rating CI-4 or better (ACEA Rating E3 for Europe).
			—	Change ELC (red) engine coolant every 5 years or 12,000 hours. Units equipped with ELC have an ELC nameplate on the expansion tank (see page "ELC (Extended Life Coolant)" on page 51).
			—	Test fuel injection nozzles at least every 10,000 hours.

** 3,000 hours or two years, whichever occurs first.*

Host Unit (Continued)

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Electrical
	•	•	•	Inspect battery terminals and electrolyte level.
	•	•	•	Inspect wire harness for damaged wires or connections.
•	•	•	•	Check operation of damper door (closes on defrost initiation and opens on defrost termination).
			•	Inspect alternator wire connections for tightness.
				Refrigeration
•	•	•	•	Check refrigerant level.
	•	•	•	Check for proper suction pressure.
	•	•	•	Check throttling valve regulating pressure.
			•	Check compressor oil level and condition.
			•	Check compressor efficiency and pump down refrigeration system.
			—	Replace dehydrator and check discharge and suction pressure every two (2) years.
				Structural
•	•	•	•	Visually inspect unit for fluid leaks.
•	•	•	•	Visually inspect unit for damaged, loose or broken parts (includes air ducts and bulkheads).
	•	•	•	Inspect tapered roller bearing fanshaft and idlers for leakage and bearing wear (noise).
	•	•	•	Clean entire unit including condenser and evaporator coils and defrost drains.
	•	•	•	Check all unit and fuel tank mounting bolts, brackets, lines, hoses, etc.
	•	•	•	Check evaporator damper door adjustment and operation.

** 3,000 hours or two years, whichever occurs first.*

Remote Evaporator (If Used)

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Electrical
	•	•	•	Inspect wire harness for damaged wires or connections.
	•	•	•	Inspect/replace DC fan motors.
				Structural
•	•	•	•	Visually inspect unit for fluid leaks.
•	•	•	•	Visually inspect unit for damaged, loose, or broken parts.
	•	•	•	Clean entire unit including evaporator coils and defrost drains.
			•	Check all unit mounting bolts, brackets, lines, hoses, etc.

Unit Description

General Description

The Spectrum DE is a diesel powered, multi-temperature refrigeration system. The unit provides heavy duty temperature control for multiple compartment trailers. The Spectrum DE 30-2 unit is equipped with a dual evaporator. The unit mounts on front of the trailer. Two separate temperature controlled trailer compartments can be used without the need for a remote evaporator. Each side of the dual evaporator serves one side of the trailer, which is split longitudinally. The compartment to the control box side of the unit is called Zone 1. The compartment to the compressor side of the unit is called Zone 2. The compartments can carry fresh, frozen, and/or dry products. Each compartment can be quickly changed to carry any type of product.

In the Spectrum DE 30-3 a remote Spectrum Evaporator is added to provide a third compartment (Zone 3).

Brief descriptions of the following components and features are given below:

- Host Unit (Zone 1 and Zone 2)
- Spectrum Remote Evaporator (Zone 3)
- Thermo King TK 486 Engine
- Thermo King X430L Compressor
- Smart Reefer Multi-Temp µP-IV Microprocessor
- CYCLE-SENTRY^{TM} Start-Stop Controls
- DAS (Optional)
- Remote Control Box (Optional).

Host Unit

The host unit contains the diesel engine, the compressor, the condenser, the dual evaporator and the control box. The unit is equipped with a Smart Reefer Multi-Temp µP-IV Microprocessor, which controls the operation of the host unit, the dual evaporators, and remote evaporator (where used). Refrigeration lines and wire harness connect the host unit to the remote evaporator (where used).

The host unit mounts on the front of the trailer with the dual evaporator extending through a hole in the front wall into separate compartments inside the trailer.

Units manufactured after the third quarter of 2004 are being built with plastic skins.

AJA1015

Figure 1: Front View (Old Skins)

ARD188

Figure 2: Front View (New Skins)

Spectrum Remote Evaporator

A Spectrum Remote Evaporator is mounted on the ceiling of the remote compartment to provide temperature control Zone 3 (if used). A Spectrum Remote Evaporator with two fans is called an S-2. A Spectrum Remote Evaporator with three fans is called an S-3.

Figure 3: S-3 Spectrum Remote Evaporator

Thermo King TK 486 Engine

The unit uses a quiet running Thermo King TK 486, 4-cylinder, water cooled, direct injection diesel engine. The TK 486 displaces 2.09 liters and is rated at 33.9 horsepower (25.3 kilowatts) at 2200 rpm. The engine is connected directly to the compressor. Belts transmit power to the fans, alternator, and water pump.

Thermo King X430L Compressor

The unit is equipped with a Thermo King X430L, four-cylinder compressor with 30 cu. in. (492 cm^3) displacement. The unit is also equipped with a compressor oil filter.

Units built before mid-February 2003 are equipped with compressors that have a 4-quart sump. Units built after mid-February 2003 are equipped with compressors that have a 7-quart sump. See “Compressor Sump Sizes” on page 73.

Smart Reefer Multi-Temp µP-IV Microprocessor

The Smart Reefer Multi-Temp µP-IV is a microprocessor control system designed for a Smart Reefer Multi-Temp transport refrigeration system. The Smart Reefer Multi-Temp µP-IV integrates the following functions: thermostats, digital thermometers, hourmeters, oil pressure gauge, water temperature gauge, ammeter, voltmeter, tachometer, mode indicator, refrigeration system controller, and diagnostic system.

The CYCLE-SENTRY™ system and integral defrost timers are standard features. DAS and a remote control box are optional features.

The microprocessor mounts inside a weather tight control box. The display is clearly visible through a transparent cover. Opening the keypad door provides quick access to the microprocessor keypad. The keypad is used to control the operation of the microprocessor.

CYCLE-SENTRY Start-Stop Controls

A CYCLE-SENTRY Start-Stop fuel saving system provides optimum operating economy.

WARNING: When the Zone 1/Host On/Off switch is in the On position, the unit may start at anytime without prior warning.

NOTE: A buzzer sounds when the unit is automatically preheating.

The CYCLE-SENTRY system automatically starts the unit on microprocessor demand, and shuts down the unit when all demands are satisfied. In addition to maintaining the compartment temperatures, engine block temperature and battery charge levels are monitored and maintained. If the block temperature falls below 30 F (-1 C), the engine will start and run until the block temperature is above 90 F (32 C). If the battery voltage falls to the programmed limit selected by CYCLE-SENTRY Battery Voltage (typically 12.2 volts) and Diesel CYCLE-SENTRY mode is selected, the engine will start and run until the charge rate falls below that programmed by CYCLE-SENTRY Amps (typically 5 amperes).

Features of the CYCLE-SENTRY system are:

- Offers either CYCLE-SENTRY or Continuous Run operation.
- Microprocessor controlled all season temperature control.
- Maintains minimum engine temperature in low ambient conditions.
- Battery Sentry™ keeps batteries fully charged during unit operation.
- Variable preheat time.
- Preheat indicator buzzer.

DAS (Optional)

The DAS (Data Acquisition System) is an independent data logger that logs information from dedicated external DAS sensors and inputs. The DAS features up to six directly connected sensors. The DAS is also connected through a serial port to the unit microprocessor. This allows unit operating information to be logged as well.

The data can be retrieved using an IBM® PC compatible laptop or desktop computer and Thermo King WinTrac™ 4.1 (or higher) software. The computer is connected to the Computer Port on the front of the control box. Detailed graph or table trip reports can then be created. A brief graphical or tabular report can be printed on a compatible printer (P/N 204-844 or P/N 204-1020). The printer is connected to the Printer Port on the front of the control box. Refer to the DAS Data Acquisition System Manual TK 50565 for more information.

Remote Control Box (Optional)

The remote control box is mounted in a remote location (such as inside the trailer) and is used to operate the unit. Each zone can be turned on and off and the setpoints can be changed. Refer to the Operator's Manual or the appropriate Microprocessor Diagnosis Manual for complete information about the operation of the remote control box.

Sequence of Operation

The Zone 1/Host On/Off switch must be turned On before any other zone will operate. When the Zone 1/Host On/Off switch is turned On, the backlight illuminates the display and the operating icons appear. The unit will start automatically in both Continuous Run and CYCLE-SENTRY modes.

The microprocessor uses a complex program to determine which operating mode each zone should be in. Therefore, it is difficult to predict which operating mode an evaporator should be in by comparing its setpoint to the compartment temperature. Also, the different versions of software that are used have some operational differences.

Each zone that is turned on will operate in one of the following modes:

- Cool
- Heat
- Defrost
- Null

During engine operation, engine speed is determined by a combination of the requirements of each zone and the discharge pressure. The diesel engine will operate in High or Low Speed accordingly.

Defrost

Defrost is initiated automatically by the microprocessor or manually by selecting defrost from the Defrost Prompt Screen for the desired zone. A Demand Defrost cycle will also occur based on the return air temperature and discharge air temperature or coil temperature. The evaporator coil temperature must be below 45 F (7 C) to allow defrost. When the Defrost Icon for a zone appears, the damper door is closed or the fans are turned off. Several defrost features are programmable. The unit is designed to defrost in low speed.

The zone will stay in defrost until the evaporator coil temperature rises to 58 F (14 C). If the evaporator coil temperature does not rise above 58 F (14 C) within the Defrost Duration (DDUR) time limit, the microprocessor will terminate defrost and display the Alarm Icon. The Defrost Duration can be set for either 30 or 45 minutes.

System Operation

Several operating characteristics of the unit are:

- All zones can cool at the same time.
- All zones can heat at the same time.
- Any zone can cool while any other zone heats.
- When a zone is in null, the blowers may run but the zone does not cool or heat.
- When a zone is in heat while another zone is in cool, the evaporator in the zone that is in heat acts as the condenser.
- The condenser inlet solenoid and the suction line solenoids are normally open solenoid valves that close when energized.
- The liquid line solenoids, the hot gas solenoids, the receiver tank pressure solenoid and the purge valve are normally closed solenoid valves that open when energized.
- The flow of refrigerant through the system is controlled by the solenoid valves and the check valves.
- If the condenser inlet solenoid is energized (closed) because a zone is in heat or defrost, and if the discharge pressure exceeds 400 psi (2758 kPa), the condenser inlet solenoid is de-energized until the discharge pressure drops below 250 psi (1724 kPa).
- The receiver tank pressure solenoid and the purge valve are energized (open) when any zone is in heat or defrost. If the discharge pressure exceeds 300 psi (2068 kPa), the receiver tank pressure solenoid and the purge valve are de-energized until the discharge pressure drops below 225 psi (1551 kPa).
- During engine operation when all zones are in cool, the microprocessor will shift the engine to low speed if the discharge pressure exceeds 425 psi (2930 kPa). High speed is enabled, if required, when the discharge pressure drops below 375 psi (2586 kPa).

- During engine operation when all zones are in heat, the microprocessor will shift the engine to low speed if the discharge pressure exceeds 375 psi (2586 kPa). High speed is enabled, if required, when the discharge pressure drops below 300 psi (2068 kPa).

Refrigeration System Diagrams

The following pages show examples of the refrigerant flow through a three zone system. The two zone system is similar, except the Zone 3 evaporator and its components are removed.

Zone 1 Cool, Zone 2 Cool, and Zone 3 Cool

High pressure refrigerant vapor leaves the compressor and flows through the open CIS to the condenser where the refrigerant condenses into high pressure liquid. The liquid refrigerant flows through the receiver tank into the liquid lines.

The LLS is open so some of the refrigerant flows through the Zone 1 expansion valve into the Zone 1 evaporator. There the liquid refrigerant cools the Zone 1 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLCV and the accumulator.

The LLS2 is open so some of the refrigerant flows through the Zone 2 expansion valve into the Zone 2 evaporator. There the liquid refrigerant cools the Zone 2 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS2, the suction line, the SLCV2, and the accumulator.

The LLS3 is open so some of the refrigerant flows through the Zone 3 expansion valve into the Zone 3 evaporator. There the liquid refrigerant cools the Zone 3 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS3, the suction line, the SLCV3, and the accumulator.

Host Unit and Zone 1 Evaporator

1. Liquid Line Solenoid (LLS)**—Open**
2. Liquid Return Check Valve (LRCV)**—Closed**
3. Suction Line Check Valve (SLCV)**—Open**
4. Suction Line Solenoid (SLS)**—Open**
5. Hot Gas Solenoid (HGS)**—Closed**
6. Condenser Inlet Solenoid (CIS)**—Open**
7. Condenser Inlet Check Valve (CICV)**—Open**
8. Receiver Tank Pressure Solenoid (RTPS)**—Closed**
9. Condenser Check Valve (CCV)**—Open**
10. Bypass Hand Valve
11. Purge Valve (PV)**—Closed**
12. Purge Check Valve (PCV)**—Closed**

Zone 2 Evaporator

1C. Zone 2 Liquid Line Solenoid (LLS2)**—Open**

2C. Zone 2 Liquid Return Check Valve (LRCV2)**— Closed**

3C. Zone 2 Suction Line Check Valve (SLCV2)**— Open**

4C. Zone 2 Suction Line Solenoid (SLS2)**—Open**

5C. Zone 2 Hot Gas Solenoid (HGS2)**—Closed**

Zone 3 Evaporator

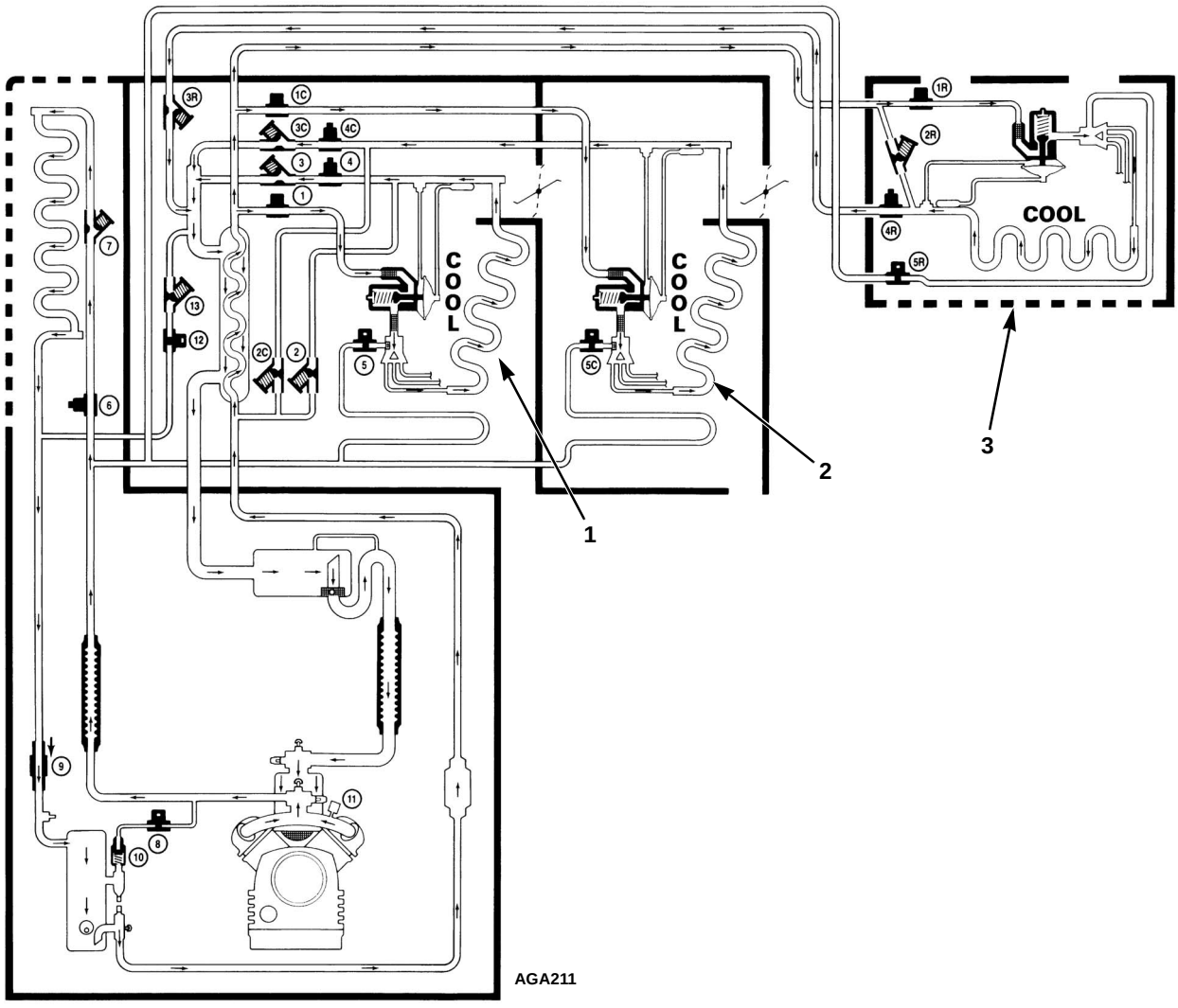
1R. Zone 3 Liquid Line Solenoid (LLS3)**—Open**

2R. Zone 3 Liquid Return Check Valve (LRCV3)**— Closed**

3R. Zone 3 Suction Line Check Valve (SLCV3)**— Open**

4R. Zone 3 Suction Line Solenoid (SLS3)**—Open**

5R. Zone 3 Hot Gas Solenoid (HGS3)**—Closed**



1.	Zone 1—Control Box Side Evaporator
2.	Zone 2—Compressor Side Evaporator
3.	Zone 1—Remote Evaporator

Figure 4: Zone 1 Cool, Zone 2 Cool, and Zone 3 Cool

Zone 1 Cool, Zone 2 Cool, and Zone 3 Heat

The CIS is closed so high pressure refrigerant vapor leaves the compressor and flows through the hot gas line and the open HGS3 into the Zone 3 evaporator. There the refrigerant heats the Zone 3 evaporator and condenses into high pressure liquid. Because the SLS3 is closed, the liquid refrigerant flows through the LRCV3 and the remote liquid line to LLS and LLS2.

The LLS is open so some of the refrigerant flows through the Zone 1 expansion valve into the Zone 1 evaporator. There the liquid refrigerant cools the Zone 1 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLCV, and the accumulator.

The LLS2 is also open so some of the refrigerant flows through the Zone 2 expansion valve into the Zone 2 evaporator. There the liquid refrigerant cools the Zone 2 evaporator as it evaporates into low pressure vapor. The refrigerant returns to the compressor through the SLS2, the suction line, the SLCV2, and the accumulator.

Host Unit and Zone 1 Evaporator

1. Liquid Line Solenoid (LLS)**—Open**
2. Liquid Return Check Valve (LRCV)**—Closed**
3. Suction Line Check Valve (SLCV)**—Open**
4. Suction Line Solenoid (SLS)**—Open**
5. Hot Gas Solenoid (HGS)**—Closed**
6. Condenser Inlet Solenoid (CIS)**—Closed***
7. Condenser Inlet Check Valve (CICV)**—Closed**
8. Receiver Tank Pressure Solenoid (RTPS)**—Open***
9. Condenser Check Valve (CCV)**—Closed**
10. Bypass Hand Valve
11. Purge Valve (PV)**—Open***
12. Purge Check Valve (PCV)—**Open**

* The microprocessor will open and close these valves as required to control the head pressure or compensate for high ambient temperatures.

Zone 2 Evaporator

1C. Zone 2 Liquid Line Solenoid (LLS2)**—Open**

2C. Zone 2 Liquid Return Check Valve (LRCV2)**— Closed**

3C. Zone 2 Suction Line Check Valve (SLCV2)**— Open**

4C. Zone 2 Suction Line Solenoid (SLS2)**—Open**

5C. Zone 2 Hot Gas Solenoid (HGS2)**—Closed**

Zone 3 Evaporator

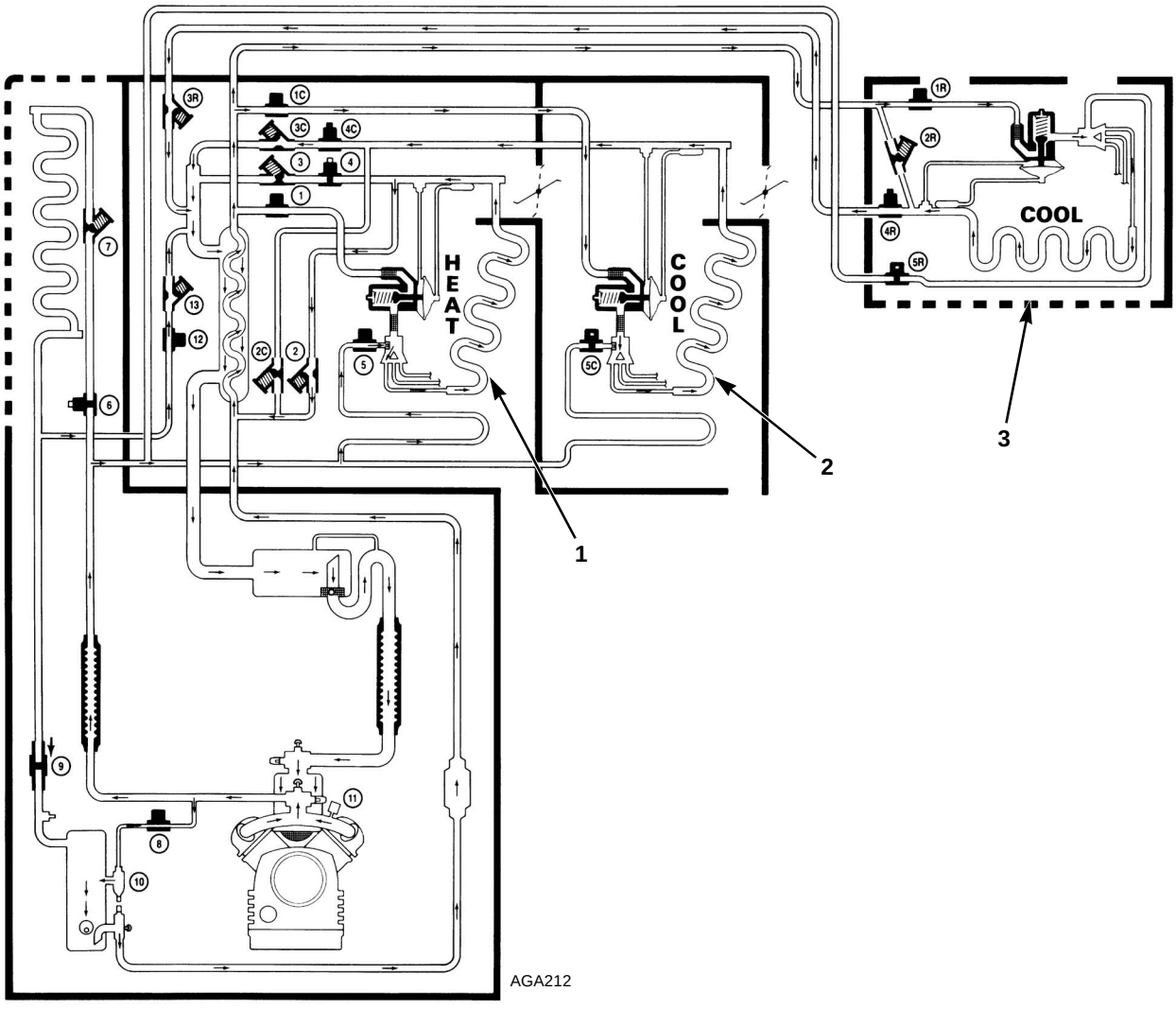
1R. Zone 3 Liquid Line Solenoid (LLS3)**—Open**

2R. Zone 3 Liquid Return Check Valve (LRCV3)**— Open**

3R. Zone 3 Suction Line Check Valve (SLCV3)**— Closed**

4R. Zone 3 Suction Line Solenoid (SLS3)**—Closed**

5R. Zone 3 Hot Gas Solenoid (HGS3)**—Open**



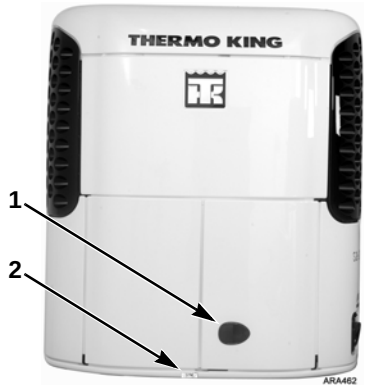
1.	Zone 1—Control Box Side Evaporator
2.	Zone 2—Compressor Side Evaporator
3.	Zone 1—Remote Evaporator

Figure 5: Zone 1 Heat, Zone 2 Cool, and Zone 3 Cool

Design Features	Spectrum DE 30-2	Spectrum DE 30-2
TK 486 Diesel Engine	•	•
X430L Compressor with Ester Base Compressor Oil	•	•
Compressor Oil Filter	•	•
Stainless Steel Evaporator Hardware	•	•
Tapered Roller Bearing Fanshaft and Idler	•	•
Premium Drive Belts	•	•
3000 Hour Cyclonic Air Cleaner	•	•
3000 Hour Fuel Filter/Water Separator	•	•
3000 Hour Dual Lube Oil Filter	•	•
5 Year/12,000 Hour (Service Interval) Extended Life Coolant (ELC)	•	•
Smart Reefer Multi-Temp µP-IV Microprocessor Controller	•	•
CYCLE-SENTRY System	•	•
Refrigerant 404A	•	•
120 Amp Alternator	•	•
Spectrum Remote Evaporator	–	•
Silicone Coolant Hoses	•	•
Communications (Data Logging with DAS)	Opt	Opt
Remote Control Panel	Opt	Opt
Fuel Heater	Opt	Opt
Frost Plug Heater	Opt	Opt
Dealer Installed Synthetic Engine Oil	Opt	Opt

Opening the Front Doors

Pull the door latch handle to open the door and access the engine compartment. Slam the door to close it. Do not push the door closed while holding the door latch handle open or the door will not close properly.

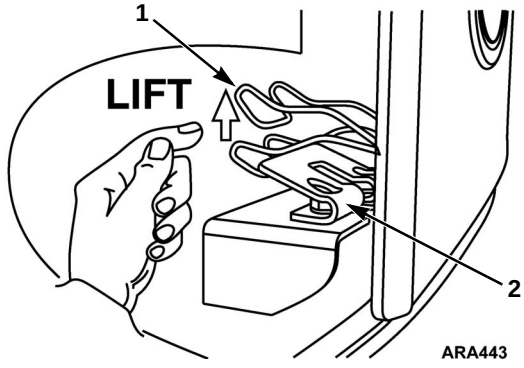


1.	Door Latch
2.	Secondary Door Latch Nameplate

Figure 6: Door Latch Location

Opening the Secondary Door Latch

Later model units are equipped with a secondary door latch. These units also have a secondary door latch nameplate located below the front doors. After opening the door latch, reach between the front doors and lift the spring latch over the spring catch while opening the door.



1.	Spring Latch
2.	Spring Catch

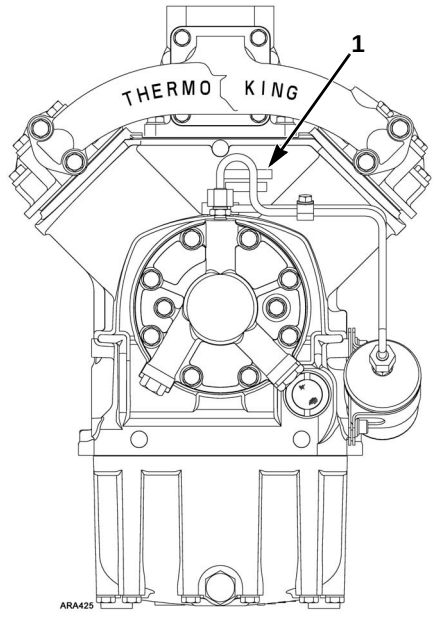
Figure 7: Opening Secondary Door Latch

Serial Number Locations

Unit: Located on the bulkhead above the compressor inside the curbside door, and on the top, roadside corner in the rear of the evaporator.

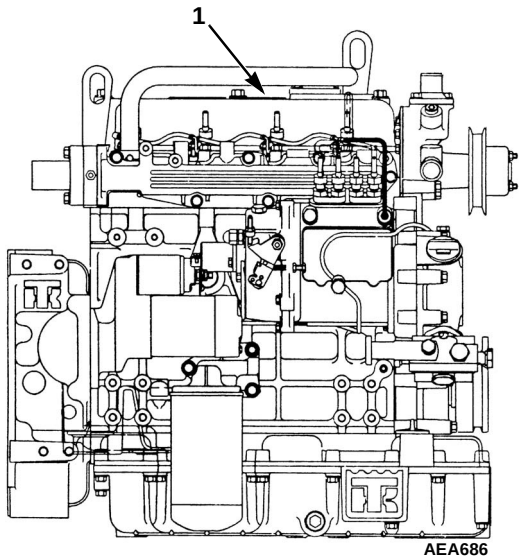
Engine: Stamped on an nameplate on the valve cover.

Compressor: Stamped on the end above the oil pump.



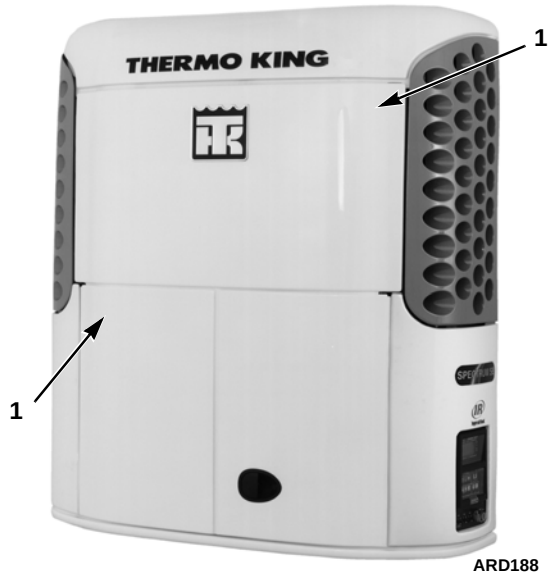
1.	Serial Number Location

Figure 8: Compressor Serial Number Location



1.	Serial Number Location

Figure 9: Engine Serial Number Location



1.	Serial Number Location

Figure 10: Unit Serial Number Location

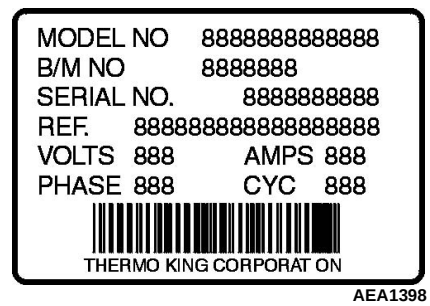
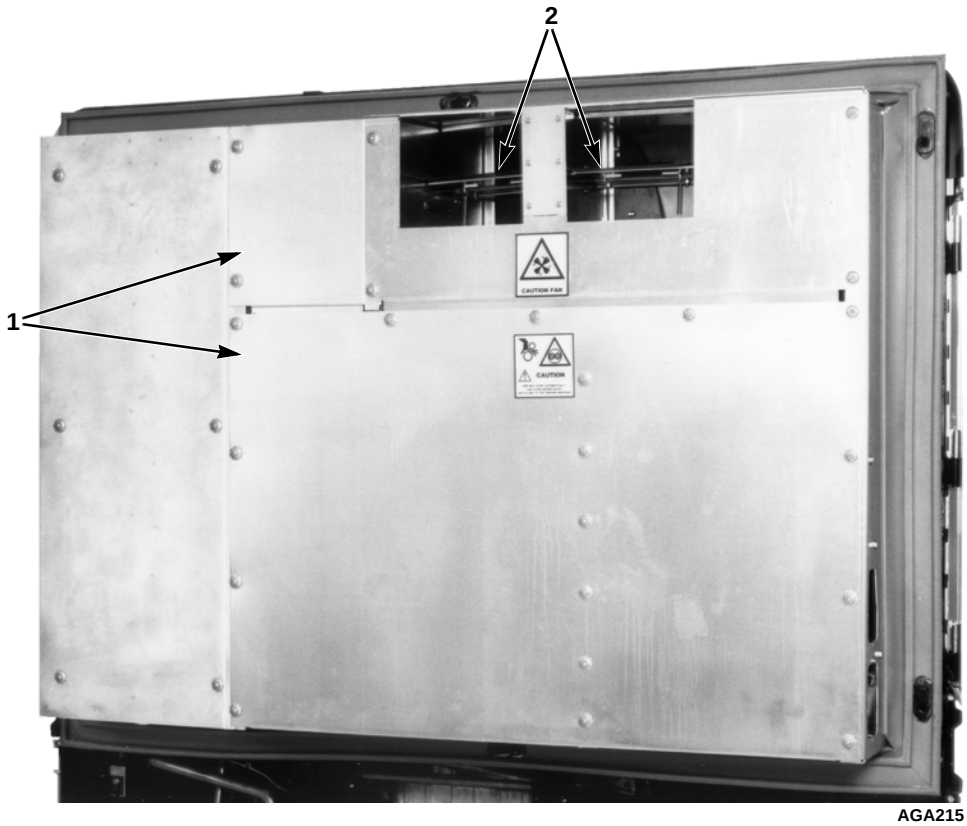
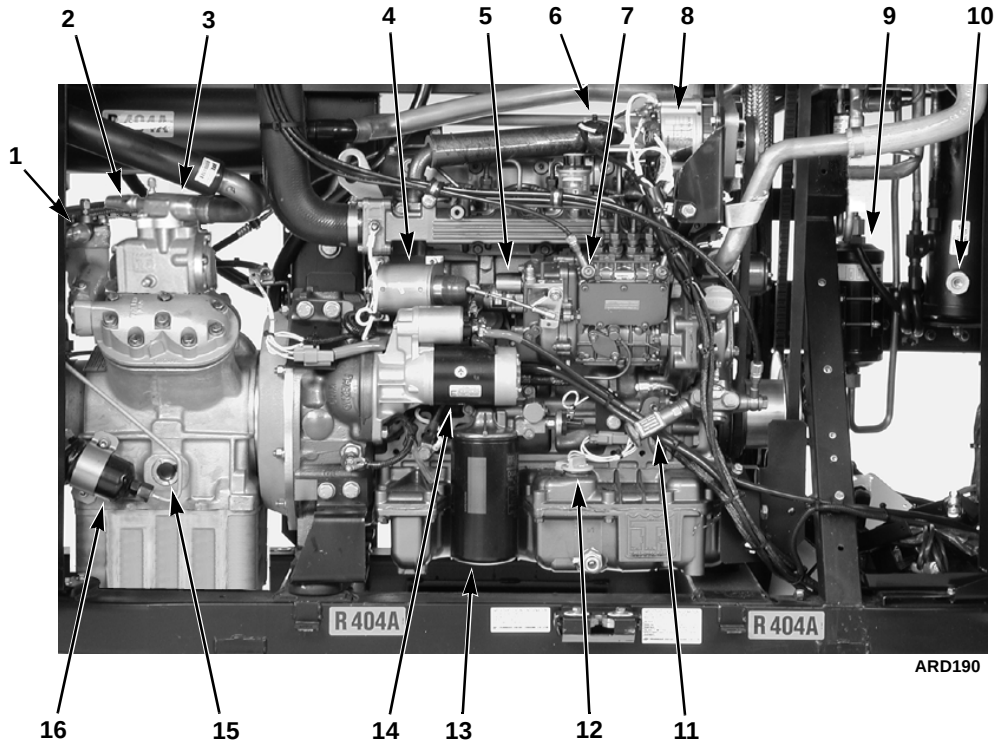


Figure 11: Laminated Serial Number Plate (Located Where Shown Above)



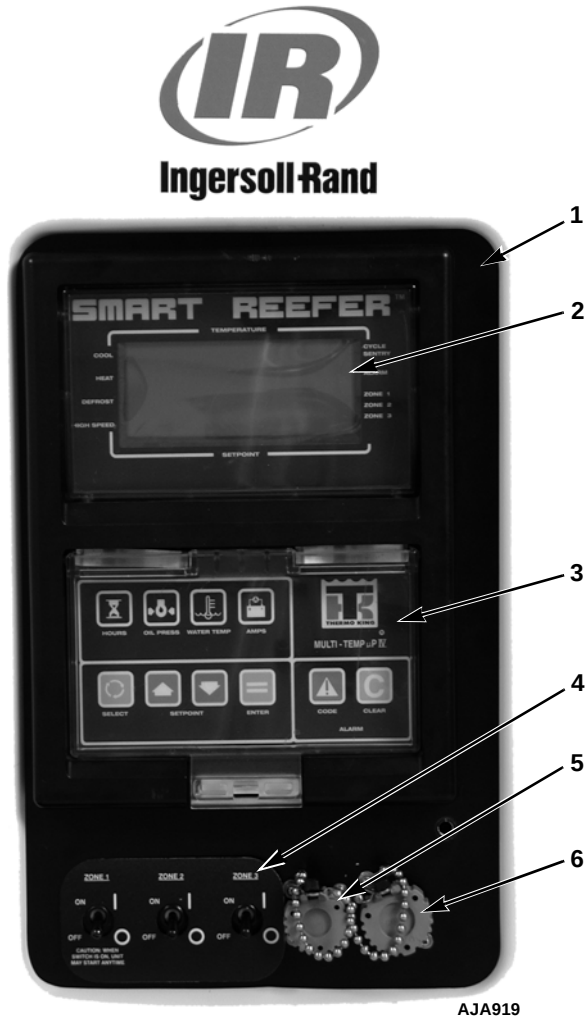
1.	Access Panels
2.	Defrost Dampers

Figure 12: Back View of Unit



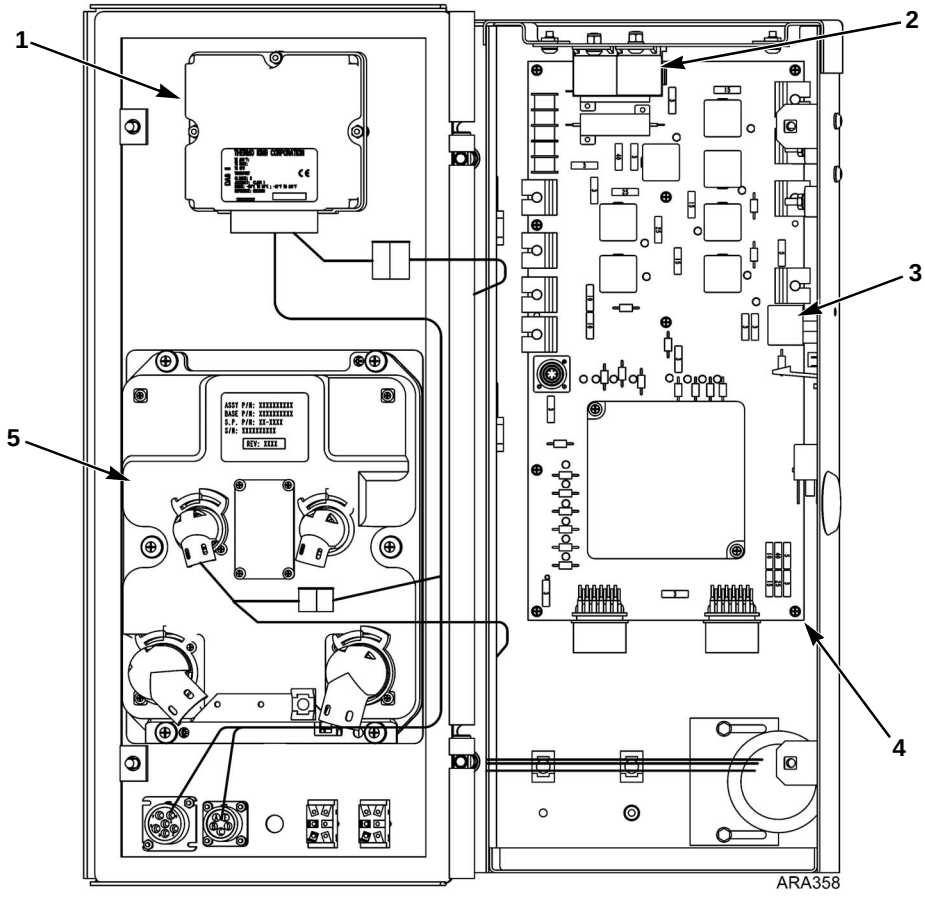
1.	Discharge Service Valve	9.	Filter-Drier
2.	Suction Service Valve	10.	Receiver Tank Sight Glass
3.	Throttling Valve	11.	Hand Primer Pump
4.	Throttle Solenoid	12.	Dipstick
5.	Fuel Solenoid	13.	Oil Filter
6.	Air Restriction Indicator	14.	Starter
7.	Fuel Bleed Screw	15.	Compressor Sight Glass
8.	Alternator	16.	Compressor Oil Filter

Figure 13: Engine Compartment



1.	Microprocessor Control Panel
2.	Display
3.	Keypad
4.	Switch Panel (3 Temp Unit Shown)
5	Computer Port (Optional)
6	Printer Port (Optional)

Figure 14: Control Panel



1.	DAS Module (Optional)
2.	Fan Relays (FR33 and FR32)
3.	Fuel Solenoid (Pull-In) Relay
4.	Relay Board
5.	Microprocessor

Figure 15: Typical Components Inside Control Box

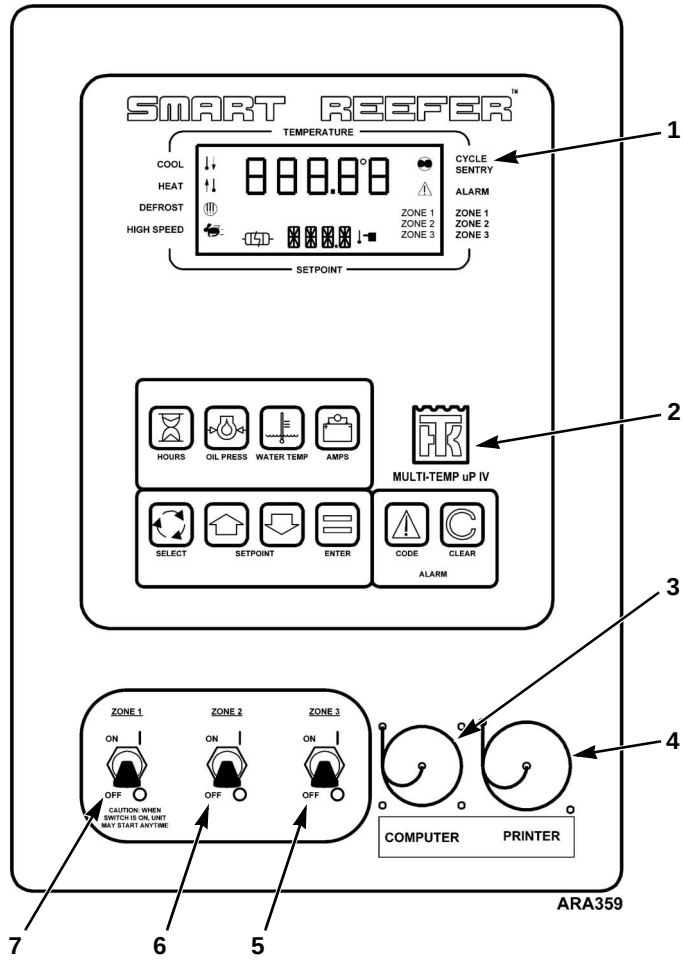
Control Panel

Most of the controls used to operate the unit are located on the control panel. Refer to the Spectrum DE Operator's Manual TK 51206 or the THERMOGUARD µP-VI Multi-Temp Microprocessor Controller Diagnosis Manual TK 50033 for more complete operating information.

Zone 1 On/Off Switch

This switch turns the host unit and the Zone 1 evaporator (control box side compartment) on and off. When the switch is in the Off position, the display will be off and the display backlight will be off. The switch should always be placed in the Off position before servicing the unit. When the switch is in the On position, the display backlight will turn on and the Standard Display will appear.

WARNING: The unit may start and run automatically any time the Zone 1 On/Off switch is in the On position.



1.	Display	5.	Zone 3 On/Off Switch (Three Temperature Units Only)
2.	Keypad	6.	Zone 2 On/Off Switch (Compressor Side Compartment)
3.	Computer Port (With DAS Option Only)	7.	Zone 1 On/Off Switch (Control Box Side Compartment)
4.	Printer Port (With DAS Option Only)		

Figure 16: Control Panel

Zone 2 On/Off Switch

This switch turns the Zone 2 evaporator (compressor side compartment) on and off.

NOTE: The Zone 2 On/Off switch will not function unless the Zone 1 On/Off Switch is in the ON position.

- On position. The Zone 2 evaporator is enabled. It will run as determined by the microprocessor to keep the temperature in the Zone 2 compartment near the Zone 2 setpoint.
- Off position. The Zone 2 evaporator is disabled and will not operate.

Zone 3 On/Off Switch

This switch is found on three temperature units, but not on two temperature units. It turns the Zone 3 evaporator on and off.

NOTE: The Zone 3 On/Off switch will not function unless the Zone 1 On/Off Switch is in the ON position.

- On position. The Zone 3 evaporator is enabled. It will run as determined by the microprocessor to keep the temperature in the Zone 3 compartment near the Zone 3 setpoint.
- Off position. The Zone 3 evaporator is disabled and will not operate.

Display

The display normally shows the Standard Display of return air temperature and setpoint for all zones whose On/Off switches are turned on. The zones will alternate in the display with each zone appearing for about 10 seconds. Other operating and unit information can also be shown here. All possible segments and operating icons are shown in the illustration on Figure 16 on page 35.

Icons

An icon will appear next to the appropriate description when the unit is operating in that mode or if an alarm condition exists. The Zone Icons indicate which zone is currently displayed.

Cool Icon: Appears when the indicated zone is operating in cool mode.

Heat Icon: Appears when the indicated zone is operating in heat mode.

Defrost Icon: Appears when the indicated zone is operating in defrost mode.

High Speed Icon: Appears when the diesel engine is operating in high speed.

Setpoint Icon: Appears when the setpoint is being shown in the lower display.

CYCLE-SENTRY Icon: Appears when the unit is operating in CYCLE-SENTRY mode.

Alarm Icon: Appears when the microprocessor detects an alarm condition.

ZONE 1
ZONE 2
ZONE 3

Zone Icons: Appear to indicate which zone is currently being shown in the display. All zones will be shown in turn (each for about 10 seconds) when the Zone 1 On/Off Switch is turned on.

Keypad

These touch sensitive keys are used to change the setpoint, view operating conditions and other unit information, and to control the unit.

HOURMETER Key: Press to display Total Hours, Engine Hours, Electric Hours, Zone 1 Hours, Zone 2 Hours, and Programmable Hours.

OIL PRESSURE Key: Press to display the engine oil pressure.

WATER TEMPERATURE Key: Allows selection of a Manual Defrost Cycle, and CYCLE-SENTRY or Continuous Mode.

OIL PRESSURE Key: Press to display the engine oil pressure.

AMPS Key: Press to display the current flow to or from the unit battery.

THERMO KING LOGO Key: Used to initiate a Pretrip Test, print, display the software revision, display clock/calendar settings, and initiate a Start of Trip.

CLEAR Key: Press to clear the alarm code shown on the display.

CODE Key: Press to display any alarm codes that may be present. [00] means no alarm codes are present.

ENTER Key: Press to load a new setpoint or other displayed setting, or to execute a prompt.

UP and DOWN ARROW Keys: Press to increase or decrease the setpoint or other displayed setting, or to change a displayed prompt.

SELECT Key: Press to select other prompt or display screens. See the following list:

[DEF1]	Defrost Zone 1 Prompt
[CYCLS]	CYCLE-SENTRY Prompt
Zone 2	Standard Display Zone 2
[DEF2]	Defrost Zone 2 Prompt
Zone 3	Standard Display Zone 3
[DEF3]	Defrost Zone 3 Prompt
[AMB.T]	Ambient Temperature Display
[BAT.V]	Battery Voltage Display
[RPM]	Engine RPM Display
[HED.P]	Head (Discharge) Pressure Display
[RET.A]	Return Air Temp Zone 1 Display
[DIS.A]	Discharge Air Temp Zone 1 Display
[TPDF]	Temp Differential Zone 1 Display
[COIL]	Evap Coil Temp Zone 1 Display
[RET.A]	Return Air Temp Zone 2 Display
[COIL]	Evap Coil Temp Zone 2 Display
[RET.A]	Return Air Temp Zone 3 Display
[COIL]	Evap Coil Temp Zone 3 Display

Computer Port

A serial cable from a computer is connected to the download port to access the Data Logging functions of the DAS. Refer to the DAS Data Acquisition System Manual TK 50565 for more information.

Printer Port

A serial cable from a printer is connected to the printer port to print a report for the directly connected DAS sensors. Refer to the Spectrum DE Operator's Manual TK 51299, or the DAS Data Acquisition System Manual TK 50565 for more information.

Unit Indicators

Receiver Tank Sight Glass: The receiver tank sight glass is used to check the amount of refrigerant in the system, and the moisture content of the refrigerant.

Compressor Oil Sight Glass: The compressor oil sight glass is used to check the relative level of compressor oil in the compressor sump.

Air Restriction Indicator: An air restriction indicator is attached to the intake manifold. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 25 in. of water column. Press the button on the top of the restriction indicator after servicing the air filter. Replace the EMI 3000 air cleaner element (see "EMI 3000 Air Cleaner" on page 66) at 3,000 hours or two years (whichever occurs first) if air clean indicator has not reached 25 in.

Remote Status Light (Optional): The remote status light indicates the operating status of the unit. The green "T" indicates the unit is functioning properly. The amber "K" indicates the unit has a check alarm but is still functioning. The green "T" and amber "K" both flash to indicate the unit has a shutdown alarm and is not functioning.

Unit Protection Devices

Fuse Link (Current Limiter): The fuse link is located in the positive battery cable. At a current draw of approximately 110 amps, the fuse link will melt, cutting all power to the unit. If the fuse link burns out, check for a grounded 2 wire before replacing the fuse link. Replace the fuse link by replacing the positive battery cable.

Fuses: A number of fuses, located on the relay board, protect various circuits and components. See "Fuses" on page 46 for more information.

High Pressure Cutout: The high pressure cutout is a pressure sensitive switch that is located in the compressor discharge manifold. If the discharge pressure rises above 470 psi (3241 kPa), the switch opens the 8D circuit to the fuel solenoid, which stops the engine.

High Pressure Relief Valve: The high pressure relief valve is designed to relieve excess pressure within the refrigeration system. The valve is a spring-loaded piston that lifts off its seat when refrigerant pressure exceeds 500 psi (3447 kPa). The valve will reseat when the pressure drops to 400 psi (2758 kPa). The valve could possibly leak refrigerant after it has relieved excess pressure. Tapping the valve lightly may help the valve reseat and *seal properly.* The valve is non-repairable and requires no adjustment. If the valve fails to reseat properly, remove the refrigerant charge and unscrew and replace the valve.

The high pressure relief valve is located on the receiver tank. Its location is such that when the pressure is expelled from the valve, it would be directed away from anyone servicing the unit.

Low Oil Level Switch: The low oil level switch closes if the oil drops below a certain level and stays closed for a specified time, the microprocessor will shut the unit down and record alarm code 66.

Preheat Buzzer: The preheat buzzer sounds when the CYCLE-SENTRY system energizes the glow plugs. This should warn anyone near the unit that the CYCLE-SENTRY system is about to start the diesel engine.

Unit Operation

Manual Pretrip Inspection (Before Starting Unit)

The following Manual Pretrip Inspection should be completed before starting the unit and loading the trailer. While the pretrip inspection is not a substitute for regularly scheduled maintenance inspections, it is an important part of the preventive maintenance program designed to head off operating problems and breakdowns before they happen.

Fuel: The diesel fuel supply must be adequate to guarantee engine operation to the next check point.

Engine Oil: The engine oil level should be at the FULL mark with the dipstick turned (threaded) into oil pan. Never overfill.

Coolant: The engine coolant must have antifreeze protection to -30 F (-34 C). Alarm Code 37 indicates low coolant. Add coolant in the expansion tank.

CAUTION: Do not remove expansion tank cap while coolant is hot.

CAUTION: Do not add "GREEN" or "BLUE-GREEN" conventional coolant to cooling systems using "RED" Extended Life Coolant, except in an emergency. If conventional coolant is added to Extended Life Coolant, the coolant must be changed after 2 years instead of 5 years.

Battery: The terminals must be clean and tight.

Belts: The belts must be in good condition and adjusted to the proper tensions.

Electrical: The electrical connections should be securely fastened. The wires and terminals should be free of corrosion, cracks or moisture.

Structural: Visually inspect the unit for leaks, loose or broken parts and other damage. The condenser and evaporator coils should be clean and free of debris. Check the defrost drain hoses and fittings to make sure they are open. Make sure all the doors are latched securely.

Starting Unit With Electronic Full Pretrip Test

This procedure is used for a complete checkout of the trailer, unit, and unit control circuits. It should be used when first starting the unit for a trip before the cargo is loaded. A full Pretrip test procedure may take up to 30 minutes and the unit will run unattended.

1. Perform a Manual Pretrip Inspection.
2. Adjust the setpoints to the desired load temperatures (refer to the appropriate Microprocessor Diagnosis Manual for detailed information about adjusting the setpoints).
   a. Use the Select key to display the Standard Display for the zone whose setpoint is to be changed.
   b. Change the setpoint display with the **ARROW** keys.

c. Enter the new setpoint by pressing the **ENTER** key within 5 seconds.

3. Initiate a Pretrip Test (refer to the appropriate Operator's Manual or Microprocessor Diagnosis Manual for detailed information about the pretrip). This procedure is automatic and can be performed on the way to the loading area or while waiting to load.

   a. Place all the On/Off switches in the On position.

   b. Clear any alarms.

   c. Press and hold the **TK** key for at least 3 seconds.

      - PRE TRIP will appear on the display.

   d. Press the **ENTER** key while PRE TRIP is displayed.

      - PRE LOAD will appear on the display and the pretrip test will start.
      - PRE AMPS will appear on the display indicating that the amps check is running and the pretrip has started.
      - The amps check will continue for several minutes, then the unit will start automatically and the operational tests will be performed.

4. When the Pretrip Test is complete, PASS, CHECK, or FAIL will appear on the display until a function key (e.g., **SELECT** or **ENTER**) is pressed. Continue as follows:

   - PASS—The unit is running and no alarms have been recorded. The unit has passed the pretrip. Go to step 6.
   - CHECK—The unit is running but Check Alarms have been recorded. Go to step 5.
   - FAIL—The unit has shut down, recorded Alarm Code 28, and possibly recorded other Shutdown Alarms. Go to step 5.

5. View the Alarms with the **CODE** key (refer to the appropriate Microprocessor Diagnosis Manual for detailed information about alarms).

   a. Correct the alarm conditions.

   b. Clear the alarms with the **CLEAR** key (refer to the appropriate Microprocessor Diagnosis Manual for detailed information about alarms).

   c. Repeat the Pretrip Test until PASS appears (the unit passes the pretrip).

6. Recheck the setpoints.

7. Complete the "After Start Inspection" on page 40.

Selection of Operating Modes

The Thermo King CYCLE-SENTRY system is designed to save refrigeration fuel costs. The savings vary with the commodity, ambient temperatures and trailer insulation. However, not all temperature controlled products can be properly transported using CYCLE-SENTRY operation. Certain highly sensitive products normally require continuous air circulation.

The microprocessor has a CYCLS screen, which is used to select CYCLE-SENTRY (CYCLS YES) or Continuous Run (CYCLS No) operation. Refer to the appropriate Operator's Manual or Microprocessor Diagnosis Manual for more information about CYCLE-SENTRY selection.

Your selection of the operating mode for the proper protection of a particular commodity should use the following guidelines:

Examples of Products Normally Acceptable for CYCLE-SENTRY Operation

- Frozen foods (in adequately insulated trailers)
- Boxed or processed meats
- Poultry
- Fish
- Dairy products
- Candy
- Chemicals
- Film
- All non-edible products

Examples of Products Normally Requiring Continuous Run Operation for Air Flow

- Fresh fruits and vegetables, especially asparagus, bananas, broccoli, carrots, citrus, green peas, lettuce, peaches, spinach, strawberries, sweet corn, etc.
- Non-processed meat products (unless pre-cooled to recommended temperature)
- Fresh flowers and foliage

These listings are not all inclusive. Consult your grower or shipper if you have any questions about the operating mode selection of your type of load.

Restarting Unit

This procedure is used when starting units that have been shut off for short periods of time. A unit that has been shut off for a long time should be started and put through a full pretrip when first started.

1. Place the Zone 1 On/Off switch in the On position.
2. After a 10 second delay, the unit should preheat and start automatically.

   NOTE: When the CYCLE-SENTRY icon is active, the unit may not start if: the compartment temperatures are near their respective setpoints, the engine is warm, and the battery is fully charged.
3. Place the Zone 2 On/Off switch in the On position to operate the Zone 2 evaporator.
4. Place the Zone 3 On/Off switch in the On position to operate the Zone 3 evaporator.

After Start Inspection

After the unit is running, the following items can be quickly checked to confirm that the unit is running properly.

1. Oil Pressure: Check the engine oil pressure in high speed by pressing the **OIL PRESS** key. The oil pressure should read OK, not Low.
2. Ammeter: Check the ammeter reading by pressing the **AMPS** key. The ammeter should indicate normal battery charging current. It may be fairly high right after starting the unit, but should taper off as the battery is recharged.
3. Compressor Oil: The compressor oil level should be visible in the sight glass.
4. Refrigerant: Check the refrigerant charge. See “Refrigerant Charge” in the Refrigeration Maintenance chapter.
5. Pre-cooling: Make sure that the setpoints are at the desired temperatures and allow the unit to run for a minimum of 1/2 hour (longer if possible) before loading the trailer.

   This provides a good test of the refrigeration system while removing residual heat and the moisture from the trailer interior to prepare it for a refrigerated load.
6. Defrost: When the unit has finished pre-cooling the trailer interior, manually initiate defrost cycles in each compartment. This will remove the frost that builds up while running the unit to pre-cool the trailer.

   To manually initiate a Defrost cycle, press the **SELECT** key until the [dEF] screen appears, then press the **ENTER** key. This will initiate a Defrost cycle in the compartment for the active Zone icon. Refer to the appropriate Microprocessor Diagnosis Manual for more information about Manual Defrost.

   The Defrost cycle should end automatically.

   NOTE: An evaporator will not defrost unless its coil temperature is below 45 F (7 C).

Loading Procedure

1. Make sure the unit is Off before opening the doors to minimize frost accumulation on the evaporator coil and heat gain in the trailer. (Unit may be running when loading the trailer from a warehouse with door seals).
2. Spot check and record load temperature while loading. Especially note any off-temperature product.

3. Load the product so that there is adequate space for air circulation completely around the load. DO NOT block the evaporator inlet or outlet.
4. Products should be pre-cooled before loading. Thermo King transport refrigeration units are designed to maintain loads at the temperature at which they were loaded. Transport refrigeration units are not designed to pull hot loads down to temperature.

Single Temperature Loading Procedure

If all compartments are to be maintained at the same temperature and all evaporators are required to operate, it is recommended that the dividing bulkhead doors be closed to allow correct temperature management in each compartment.

Some loads require that the bulkheads be removed. In that case, run the Zone 1 and Zone 2 evaporators to control the temperature. Make sure the setpoints for Zone 1 and Zone 2 are exactly the same.

Post Load Procedure

1. Make sure all the doors are closed and locked.
2. Start the unit if it was shut off to load (see “Restarting Unit”).
3. Make sure the setpoints are at the desired settings.
4. One-half hour after loading, manually initiate defrost cycles in each compartment. If the evaporator coil sensor temperature is below 45 F (7 C), the evaporator will defrost. The microprocessor will terminate defrost automatically when the evaporator coil temperature reaches 58 F (14 C) or the evaporator has been in the Defrost mode for 30 or 45 minutes (depending on setting).

Post Trip Checks

1. Wash the unit.
2. Check for leaks.
3. Check for loose or missing hardware.
4. Check for physical damage to the unit.

Australian Bosch Alternator

Charging System Diagnostic Procedures

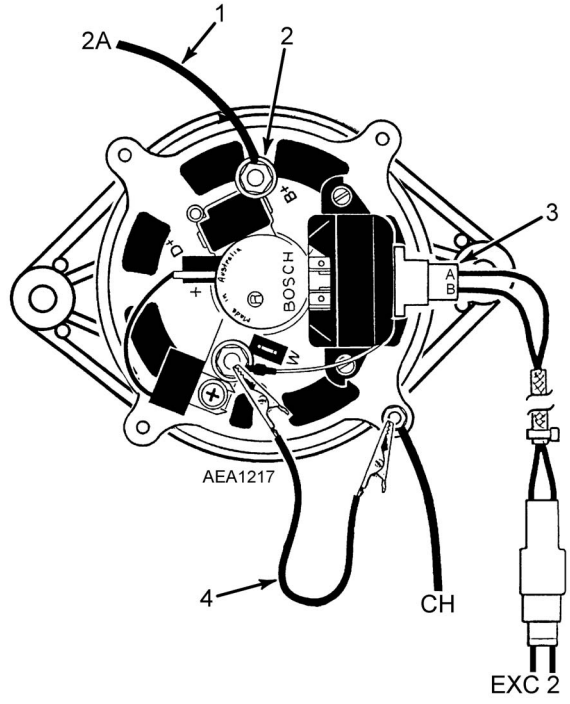
NOTE: Units manufactured with CYCLE-SENTRY and alternators with integral regulators MUST use replacement alternators with integral regulators.

CAUTION: Full-fielding alternators with the integral regulator is accomplished by installing a jumper from terminal F2 to ground. Attempting to full-field the alternator by applying battery voltage to terminal F2 will cause voltage regulator failure.

CAUTION: The F7 fuse must be removed from the relay board on units equipped with the Australian Bosch alternator. The voltage regulator will be damaged if the unit is turned On with the F7 fuse in place on the relay board.

Complete the following checkout procedure before replacing the voltage regulator or the alternator.

- When testing alternators use accurate equipment such as a Thermo King P/N 204-615 (FLUKE 23) digital multimeter and a Thermo King P/N 204-613 amp clamp or an equivalent.



1.	Check Point for 2A Amperage	3.	Check Point for Sense Circuit and Excitation Circuit Voltages
2.	Check Point for B+ Voltage	4.	Position for Full Fielding Jumper

Figure 17: Check Points for Alternator Test

- Make sure the drive belts and pulleys of the charging system are in good condition and are adjusted properly before testing the alternator. Worn belts and pulleys or loose belts will lower the output of the alternator.
- The battery must be well charged, the battery cable connections must be clean and tight, and the 2A and excitation circuits must be connected properly.

NOTE: All voltage readings should be taken between the negative battery terminal, or a good chassis ground, and the terminals indicated, unless stated otherwise.

1. Check to make sure that the F7 fuse has been removed from the relay board. If not, it must be removed, however, the voltage regulator has probably already been damaged.
2. Set the unit for Continuous Run operation and place the Zone 1 On/Off switch in the Off position.
3. Check the battery voltage. If the battery voltage is less than 12 volts, the battery must be charged or tested to determine if it should be replaced.
4. Check the voltage at the B+ terminal on the alternator. Battery voltage must be present. If not, check the 2A circuit.
5. Disconnect the alternator harness from the voltage regulator by carefully pushing on the spring clip to release the plug lock.
6. Set the unit for Continuous Run operation and place the Zone 1 On/Off switch in the On position.
7. Check the voltage at the A pin and at the B pin in the two pin connector on the alternator harness.
    a. The A pin is the battery sense circuit and should be at battery voltage. If not, check the sense circuit (2 or equivalent) in the alternator harness and in the main wire harness.
    b. The B pin is the excitation circuit and should be at 10 volts or higher. If not, check the excitation circuit (EXC or equivalent) in the alternator harness and in the main wire harness.
8. If battery voltage is present on the sense and excitation circuits, connect the alternator harness to the voltage regulator and check the voltage on the B pin in the two pin connector on alternator harness. The voltage should be 1 to 3 volts.
    a. No voltage or a voltage reading below 1 volt indicates that the rotor or the voltage regulator may be shorted. Perform the field current test to further isolate the problem.
    b. A voltage reading above 3 volts indicates that the field circuit may be open or have high resistance. The brushes or the rotor are probably defective.
9. Attach a clamp-on ammeter to the 2A wire connected to the B+ terminal on the alternator.
10. Connect a voltmeter between the B+ terminal and a chassis ground.
11. Start the unit and run it in high speed.
12. Connect a jumper wire between the F2 terminal and a chassis ground. This will full field the alternator.

    CAUTION: DO NOT full field the alternator for more than seven seconds while checking the meter readings, or the electrical system may be damaged.

13. Check the amperage in the 2A wire and record the reading. Check the voltage at the B+ terminal and continue to observe this voltage for a few seconds to see if it increases, decreases, or stays the same. Note the change in voltage and record the voltage reading.

    Amperage in the 2A wire =____amps.

    Voltage at the B+ terminals =___volts.

    The voltage at the B+ terminal should be 13 to 18 volts and the amperage in the 2A wire should be at least as high as the rated output of the alternator.

    NOTE: An alternator can easily exceed its rated output. An alternator MUST at least reach its rated output when full fielded. An alternator that has a defective rectifier diode may reach 75 percent of its rated output with a full field.

14. Stop the unit.
15. Use the readings obtained previously to determine the problem by referring to the Diagnosis Chart below.

    NOTE: This assumes that the alternator did not charge properly prior to the full field test.

Field Current Test

This test checks the field windings, brushes, and slip rings Perform this test with the Zone 1 On/Off switch in the Off position.

1. Attach a clamp-on ammeter to the 2A wire near the B+ terminal on the alternator.
2. Connect a jumper wire between the F2 terminal on the alternator and a chassis ground, and note the ammeter reading.
3. The ammeter reading indicates field current. The following chart shows the field current for a 120 amp alternator with 12 volts applied to the field:

Alternator Rating	Field Current @ 12 Volts
120 Amp	2.0 to 5.0 Amps

   a. No field current or a low field current indicates an open circuit or excessive resistance in the field circuit. Replace the voltage regulator and brush assembly, inspect the slip rings and repeat the test. If the brushes are not the problem, replace the rotor or the alternator.

   b. High field current indicates a short in the field circuit. Repair or replace the alternator.

Diagnosis Chart

Amperage in 2A	Voltage at B+	Problem/Solution
At or above rated output	At or above battery voltage and increasing	Voltage regulator defective / Replace voltage regulator and brush assembly
Approximately 60 percent of rated output	Approximately equal to battery voltage and does not change, or rises slightly	Receiver diode defective / Repair or replace alternator
Low or no output	Less than or equal to battery voltage and decreasing	Stator windings, field windings, brush or diode defective / Perform Field Current Test to check brushes and field coil, or replace alternator

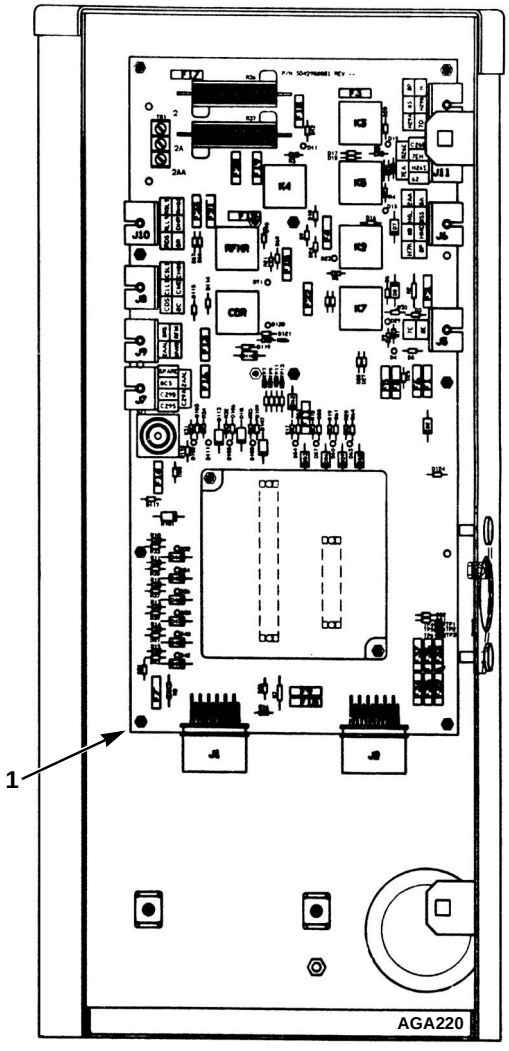
Battery

Inspect/clean the battery terminals and check the electrolyte level during scheduled maintenance inspections. A dead or low battery can be the cause of an ammeter indicating discharge due to lack of initial excitation of the alternator even after the unit has been boosted for starting. The minimum specific gravity should be 1.235. Add distilled water as necessary to maintain the proper water level.

Fuses

A number of fuses, located on the relay board, protect various circuits and components. The relay board is located inside the control box.

- A 15 amp fuse (F3—Zone 1 Damper) protects the 29A circuit, which supplies power to the damper solenoid.
- A 15 amp fuse (F4—High Speed Solenoid) protects the 7D circuit, which supplies power to the high speed solenoid.
- A 15 amp fuse (Fuse F6—Zone 1 [Host] Solenoids) protects the 7K1 circuit, which supplies power to solenoids and components in the host unit.
- A 25 amp fuse (Fuse F12—Zone 3 Fan Motors) protects the FMR3 circuit, which supplies power to the Zone 3 evaporator fan motors and relays.
- A 15 amp fuse (Fuse F13—Zone 3 Solenoids) protects the 8-3 circuit, which supplies power to solenoids and components in the Zone 3 evaporator.
- A 25 amp fuse (Fuse F15—Zone 2 Fan Motors) protects the FMR2 circuit, which supplies power to the Zone 2 evaporator fan motors and relays.
- A 15 amp fuse (Fuse F16—Zone 2 Solenoids) protects the 8-2 circuit, which supplies power to solenoids and components in the Zone 2 evaporator.
- A 40 amp fuse (F20—Control Circuit Power) protects the 2AA circuit, which is the main power circuit.
- A 15 amp fuse (Fuse F22—Host Unit Controls) protects the 8F circuit, which supplies power to various control relays and components.
- A 40 amp fuse (Fuse F23—Starter Circuit) protects the 2S circuit, which supplies power to the starter relay (K5) and the starter solenoid.
- A number of 2 and 5 amp fuses protect microprocessor circuits, control relay circuits, and various components.



1.	Relay Board

Figure 18: Control Box

Fuse Link

The fuse link is located in the positive battery cable. The fuse link protects the electric system from a short in the 2 circuit. If the fuse link burns out, check for a grounded 2 wire before replacing the fuse link. Replace the fuse link by replacing the positive battery cable.

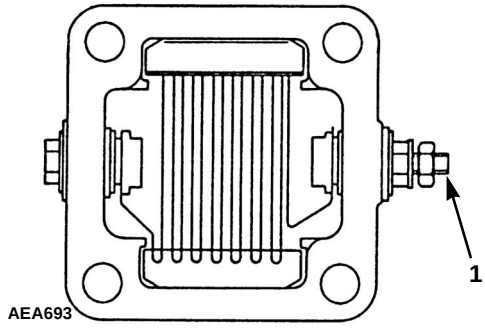
Air Heater

The air heater is mounted on the open end of the intake manifold. It heats the intake air to help the engine start in cold weather. The air heater is energized by the microprocessor during preheat, just before the engine is started.

The heater is probably defective if the resistance is more than 0.2 ohms and the current draw is less than 60 amps, or if the current draw is more than 100 amps.

Check the resistance of the air intake heater with an ohmmeter between the M6 terminal on the front of the heater and the screw on the back of the heater (or the heater case). The resistance should be 0.1 to 0.2 ohms.

Check the current draw of the heater with a clamp-on ammeter at the H1 wire near the M6 terminal on the front of the heater. During preheat the current draw should be approximately 89 amps at 12.5 volts and approximately 77 amps at 11 volts.



1.	M6 Terminal

Figure 19: Air Heater

Smart Reefer Multi-Temp µP-IV Microprocessor Controller

Refer to the appropriate Microprocessor Controller Diagnosis Manual for complete service information about the microprocessor controller and the related components.

Unit Wiring

Inspect the unit wiring and the wire harnesses during scheduled maintenance inspections for loose, chaffed or broken wires to protect against unit malfunctions due to open or short circuits.

Engine Maintenance

EMI 3000

EMI 3000 is an extended maintenance interval package. It was phased in as standard equipment on this unit in the first quarter of 2001. The EMI 3000 package consists of the following key components:

- New EMI 3000-Hour Cyclonic Air Cleaner Assembly and Air Cleaner Element
- New EMI 3000-Hour Fuel Filter (black with gold lettering)
- New EMI 3000-Hour Dual Element Oil Filter (black with gold lettering)
- API Rating CI-4 Mineral Oil (ACEA Rating E3 for Europe)
- Five Year or 12,000 Hour ELC (Extended Life Coolant).

The EMI package allows standard maintenance intervals to be extended to 3,000 hours, or 2 years, whichever occurs first.

NOTE: Units equipped with the EMI 3000 package do require regular inspection in accordance with Thermo King's maintenance recommendations.

NOTE: The new EMI 3000 oil filters and new EMI 3000 air cleaners are NOT interchangeable with the oil filters and air cleaners previously used in trailer units.

Engine Lubrication System

The TK 486 engine has a pressure lubrication system. Refer to the TK 482 and TK 486 Engine Overhaul Manual TK 50136 for a detailed description of the engine lubrication system.

Engine Oil Change

The engine oil should be changed according to the Maintenance Inspection Schedule. Drain the oil only when the engine is hot to ensure that all the oil drains out. When changing oil, keep unit and trailer level so all the oil can flow from the oil pan. It is important to get as much of the oil out as possible because most of the dirt particles are contained in the last few quarts of oil that drain out of the pan. Refill the pan with 13 quarts (12.3 liters) and check the dipstick level. Run the unit, and then recheck the oil level. The engine oil level should be at the FULL mark with the dipstick turned (threaded) into the oil pan. Never overfill. See Specifications Chapter for correct type of oil.

Oil Filter Change

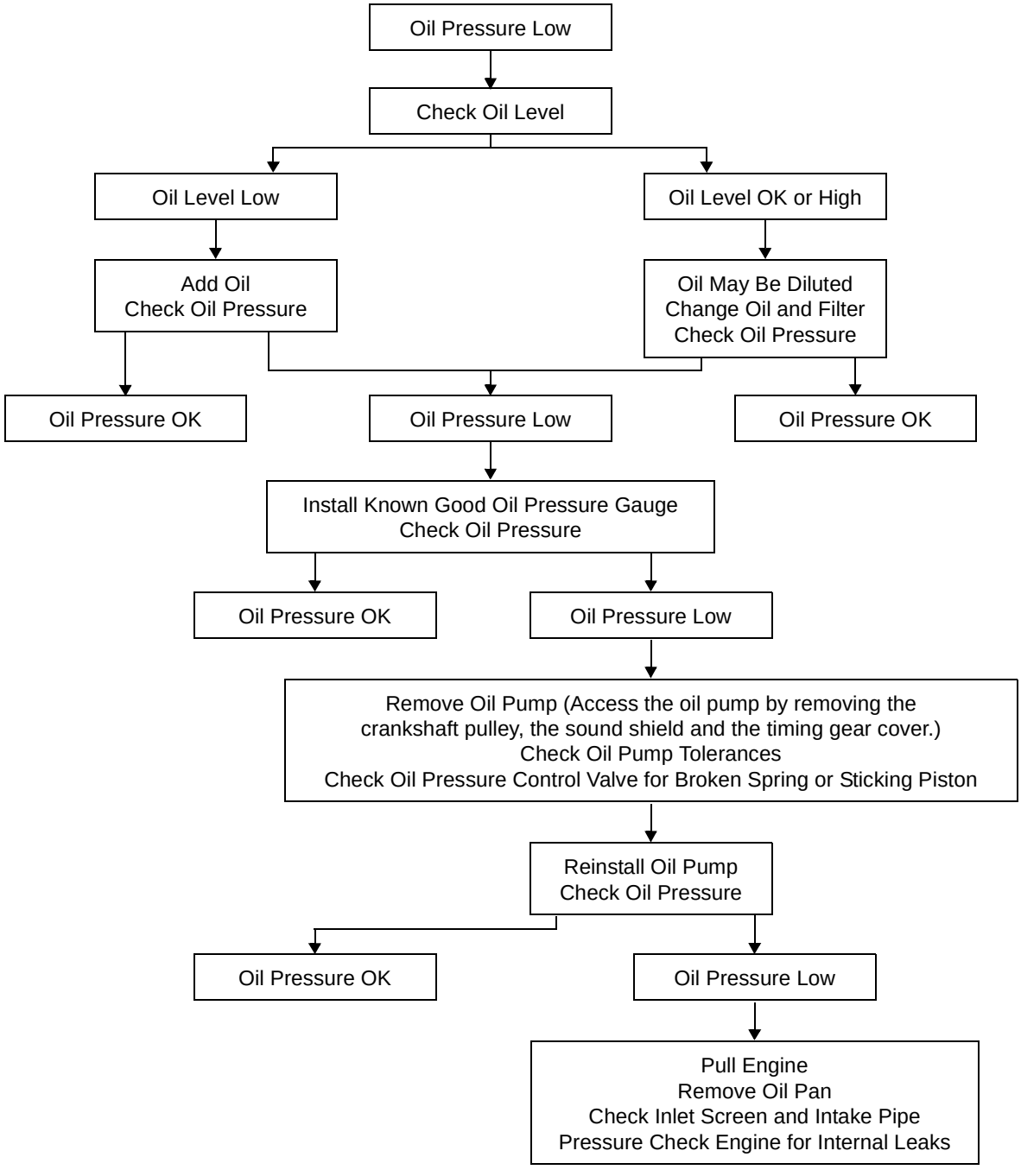
The oil filter should be changed along with the engine oil. Use a genuine Thermo King extended maintenance oil filter.

1. Remove the filter.
2. Apply oil to the rubber ring of the new filter and install the filter.
3. Tighten the filter until the rubber ring makes contact, then tighten 1/2 turn more.
4. Start the unit and check for leaks.

Low Oil Pressure

Oil pressure is affected by oil temperature, oil viscosity, and engine speed. Low oil pressure can usually be traced to the lack of oil, a faulty oil pressure regulating valve, or worn bearings. Low oil pressure is not normally caused by a faulty oil pump. Use the "Low Oil Pressure Flow Chart" on the following page to help diagnose low oil pressure.

Low Oil Pressure Flow Chart



Engine Cooling System

The engine employs a closed, circulating type, pressurized cooling system. Correct engine temperatures are controlled and maintained by a radiator, fan and thermostat. The coolant is circulated through the system by a belt driven centrifugal pump. The pump draws the coolant from the side of the radiator, circulates it through the cylinder block and head and returns it to the radiator. A thermostat mounted in the coolant outlet line from the cylinder head to the radiator automatically maintains coolant temperature within the specified temperature range.

All water cooled engines are shipped from the factory with a 50 percent permanent type antifreeze concentrate and 50 percent water mixture in the engine cooling system.

This provides the following:

1. Prevents freezing down to -30 F (-34 C).
2. Retards rust and mineral scale that can cause engine overheating.
3. Retards corrosion (acid) that can attack accumulator tanks, water tubes, radiators and core plugs.
4. Provides lubrication for the water pump seal.

ELC (Extended Life Coolant)

ELC has been phased into all trailer units equipped with TK 486 engines. A nameplate on the coolant expansion tank identifies units with ELC.

NOTE: The new engine coolant, Texaco Extended Life Coolant, is RED in color instead of the current GREEN or BLUE-GREEN colored coolants.

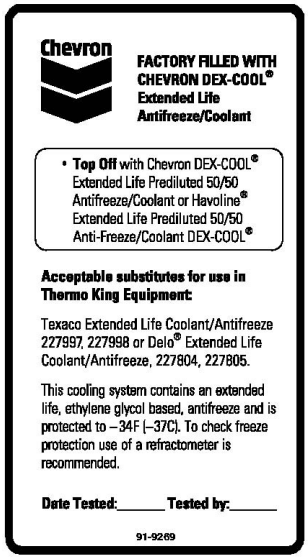


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Figure 20: ELC Nameplate Located On Expansion Tank

The following are the Extended Life Coolants currently approved by Thermo King for use in ELC units for five years or 12,000 hours:

- Chevron Dex-Cool
- Texaco ELC (nitrite free)
- Havoline Dex-Cool (With nitrites)
- Havoline Dex-Cool (nitrite free)
- Shell Dexcool
- Shell Rotella
- Havoline XLC (Europe)
- Saturn/General Motors Dex-Cool.
- Caterpillar ELC.
- Detroit Diesel POWERCOOL Plus.

CAUTION: Do not add "GREEN" or "BLUE-GREEN" conventional coolant to cooling systems using "RED" Extended Life Coolant, except in an emergency. If conventional coolant is added to Extended Life Coolant, the coolant must be changed after 2 years instead of 5 years.

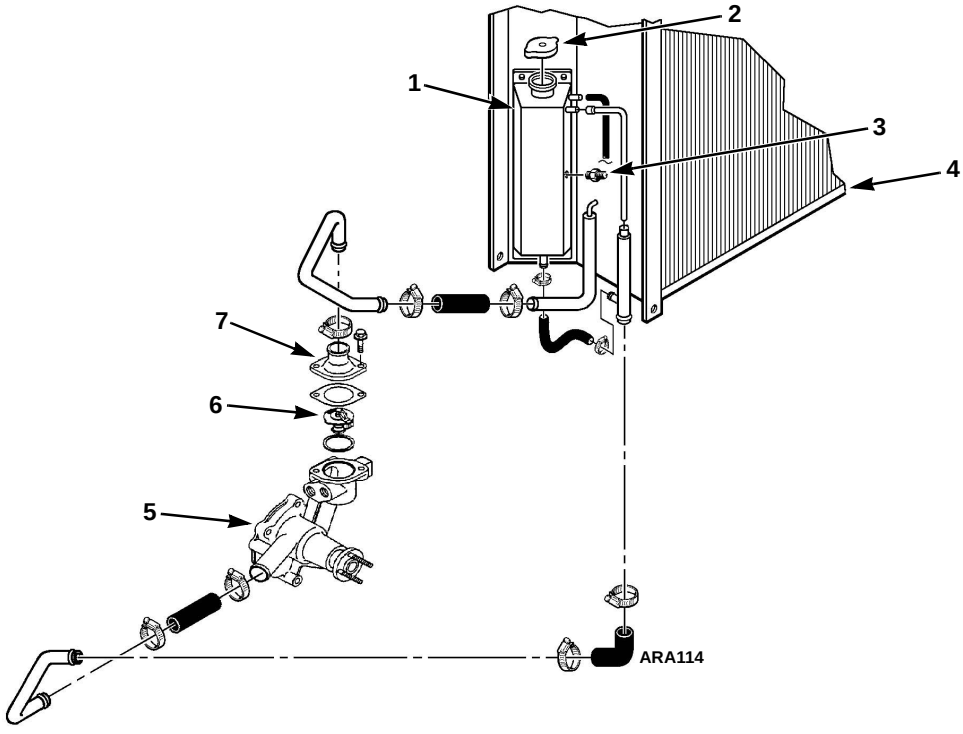
NOTE: The use of 50/50 percent pre-mixed Extended Life Coolant (ELC) is recommended to assure that de-ionized water is being used. If 100 percent full strength concentrate is used, de-ionized or distilled water is recommended over tap water to insure the integrity of the cooling system is maintained.

Antifreeze Maintenance Procedure

As with all equipment containing antifreeze, periodic inspection on a regular basis is required to verify the condition of the antifreeze. Inhibitors become worn out and must be replaced by changing the antifreeze. Change ELC (red) engine coolant every five years or 12,000 hours (whichever occurs first).

Do not mix green or blue-green engine coolant with ELC (red) engine coolant. See “ELC (Extended Life Coolant)” on page 51 for more information about ELC.

The factory recommends the use of a 50/50 antifreeze mixture in all units even if they are not exposed to freezing temperatures. This antifreeze mixture will provide the required corrosion protection and lubrication for the water pump.



1.	Expansion Tank	5.	Water Pump
2.	Radiator Cap	6.	Thermostat
3.	Coolant Level Sensor	7.	Thermostat Housing
4.	Radiator		

Figure 21: Engine Cooling System

Checking the Antifreeze

Check the solution concentration by using a temperature compensated antifreeze hydrometer or a refractometer (P/N 204-754) designed for testing antifreeze. Maintain a minimum of 50 percent permanent type antifreeze concentrate and 50 percent water solution to provide protection to -30 F (-34 C). Do not mix antifreeze stronger than 68 percent permanent type coolant concentrate and 32 percent water for use in extreme temperatures.

Changing the Antifreeze

1. Run the engine until it is up to its normal operating temperature. Stop the unit.
2. Open the engine block drain (located behind the starter) and completely drain the coolant. Observe the coolant color. If the coolant is dirty, proceed with a, b, and c. Otherwise go to 3.

CAUTION: Avoid direct contact with hot coolant.

   a. Run clear water into the radiator and allow it to drain out of the block until it is clear.
   b. Close the block drain and install a commercially available radiator and block flushing agent, and operate the unit in accordance with instructions of the flushing agent manufacturer.
   c. Open the engine block drain to drain the water and flushing solution.

CAUTION: Avoid direct contact with hot coolant.

3. Run clear water into the radiator, and allow it to drain out of the block until it is clear.
4. Inspect all hoses for deterioration and hose clamp tightness. Replace if necessary.
5. Loosen the water pump belt. Check the water pump bearing for looseness.
6. Inspect the radiator cap. Replace the cap if the gasket shows any signs of deterioration.
7. If using ELC concentrate, mix one gallon of ELC concentrate and one gallon of de-ionized or distilled water in a container to make a 50/50 mixture. (Do not add antifreeze and then add water to the unit. This procedure may not give a true 50/50 mixture because the exact cooling system capacity may not always be known.)
8. Refill the radiator with the 50/50 antifreeze mixture and make sure to bleed the air from the cooling system as needed.

Bleeding Air From The Cooling System

Jiggle pin thermostats are original equipment on units that have TK 482/486 engines. Jiggle pin thermostats make it unnecessary to bleed the air out of the engine block because they keep air from being trapped in the engine block. Normally, all but about 1.5 qt (1.4 liters) of coolant drain out of the cooling system when it is drained. If approximately half of the Cooling System Capacity (see Specifications) seems to fill the cooling system after it has been drained, air has been trapped in the block. Bleed the air out of the block using the following procedure:

CAUTION: If you suspect that air is trapped in the block, do not start the engine without bleeding the air out of the block.

NOTE: If an engine runs with air trapped in the block, the engine may be damaged. The high water temperature switch may not protect an engine that has air trapped in the block, because the high water temperature switch is designed to protect an engine from overheating due to failures in the cooling system.

1. Loosen the plug on the back of the water pump below the thermostat cover until coolant comes out of the plug fitting.
2. Tighten the plug.
3. Pour coolant into the system until it appears to be full.
4. Make sure that the amount of coolant that goes back into the system is approximately equal to the amount of coolant that came out of the system.

5. Start the unit on low speed heat, let it run for two minutes, and then shut it off.
6. Check the coolant level and add coolant if necessary.
7. Repeat steps 5 and 6 until the coolant level stabilizes.

Engine Thermostat

For the best engine operation, use a 180 F (82 C) thermostat year-round.

Engine Fuel System

The TK 486 engine is a direct injection diesel that uses an in-line injection pump.

The components of the fuel system are:

1. Fuel tank
2. Inlet strainer (prefilter)
3. Fuel filter/water separator
4. Priming pump
5. Fuel transfer pump
6. Injection pump
7. Injection nozzles

The priming pump is used to manually draw fuel from the tank up to the fuel pump if the unit should run out of fuel.

Operation

Fuel is drawn from the fuel tank and through the prefilter by the fuel transfer pump. The fuel transfer pump delivers fuel to the fuel filter/water separator. Two orifices in the filter head control the pressure in the fuel system by allowing a certain amount of fuel to return to the tank. One orifice is located in the center of the filter head. It bleeds off water. The other orifice is located off-center on the filter head. It bleeds off air. Filtered fuel passes through a line from the outlet fitting on the filter base to the injection pump.

The injection pump plungers are activated by a gear driven injection pump camshaft. The governor sleeve and weight assembly is mounted on the end of the pump camshaft. The governor's speed requirements are relayed to the injection pump through a linkage arrangement located in the rear cover. The injection pump raises the pressure of the fuel and meters the correct amount of fuel to the nozzle at the correct time. The increased fuel pressure will lift the spring loaded nozzle to admit fuel into the combustion chamber.

Injection pump leakage, injection nozzle overflow and excess fuel from the fuel filter orifice are then all sent back to the fuel tank in the return line.

Maintenance

The injection pump and fuel transfer pump are relatively trouble-free and if properly maintained will usually not require major service repairs between engine overhauls.

Contamination is the most common cause of fuel system problems. Therefore, to ensure best operating results, the fuel must be clean and fuel tanks must be free of contaminants. Change the fuel filter/water separator regularly and clean the prefilter on the inlet side of the fuel transfer pump.

NOTE: The injection nozzles should be tested (and repaired if necessary) at 10,000 hour intervals when used in normal conditions. Normal conditions are considered to be the use of clean high quality fuel, no used oil blending, and regular maintenance of the fuel system according to the Maintenance Inspection Schedule. Refer to the TK 482 and TK 486 Overhaul Manual TK 50136 for injection nozzle testing and repair procedures.

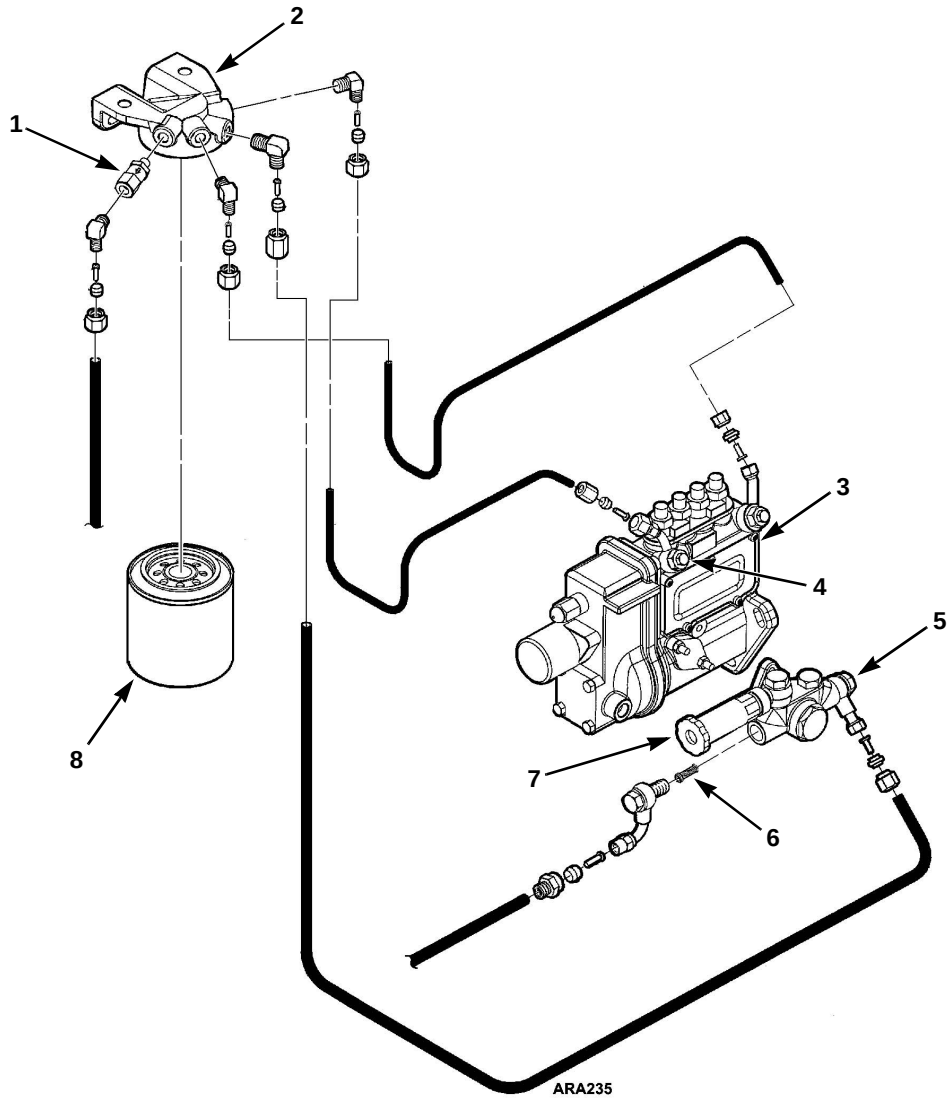
Whenever the fuel system is opened, take the following precautions to prevent dirt from entering the system:

1. Cap all fuel lines.
2. Work in a relatively clean area whenever possible.
3. Complete the work in the shortest possible time.

Any major injection pump or nozzle repairs should be done by a quality diesel injection service shop. The necessary service equipment and facilities are not found in most engine rebuild shops because of the large investment required.

The following procedures can be done under field conditions:

1. Bleeding air from the fuel system.
2. Fuel tank and filter system maintenance.
3. Priming pump (hand) replacement or repair.
4. Fuel pump replacement or repair.
5. Injection line replacement.
6. Injection pump and governor adjustments.
7. Injection pump timing.
8. Nozzle spray pattern testing and adjustment.
9. Minor rebuilding of nozzles.



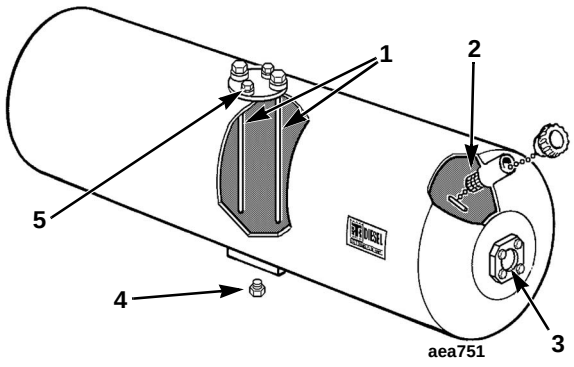
1.	Check Valve (Keeps air from entering fuel system when engine is not running.)	5.	Fuel Transfer Pump
2.	Filter Head	6.	Inlet Strainer (Prefilter)
3.	Injection Pump	7.	Priming Pump
4.	Bleed Screw	8.	Fuel Filter/Water Separator

Figure 22: Engine Fuel System

Bleeding The Fuel System

If the engine runs out of fuel, repairs are made to the fuel system, or if air gets into the system for any other reason, the air must be bled out of the fuel system.

NOTE: MAKE SURE the fuel tank vent is kept open. If the vent becomes clogged, a partial vacuum develops in the tank, and this increases the tendency for air to enter the system.

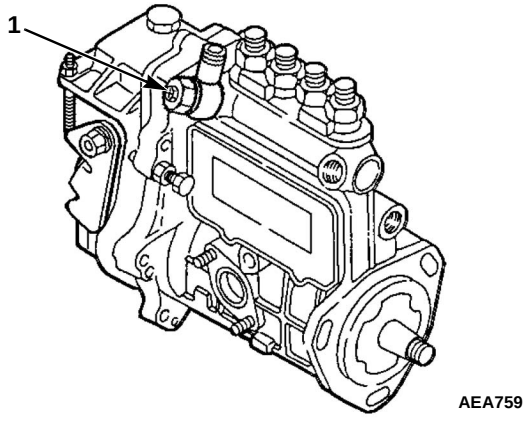


1.	Stand Pipes	4.	Drain Plug
2.	Anti-Siphon Screen (Optional)	5.	Vent
3.	Fuel Gauge		

Figure 23: Fuel Tank

To bleed air from the fuel system:

1. Loosen the bleed screw in the inlet fitting on the injection pump.



1.	Bleed Screw

Figure 24: Injection Pump

2. Unscrew the priming pump handle and manually prime the fuel system until air bubbles are no longer visible in the fuel coming out of the bleed screw.
3. Tighten the bleed screw and screw the priming pump handle back in.
4. Loosen the injection lines at the injection nozzles.
5. Crank the engine until fuel appears at the nozzles.
6. Tighten the injection lines.
7. Start the engine and observe the engine run for a few minutes. If the engine fails to start, or starts but stops in a few minutes, repeat the procedure.

Draining Water from Fuel Tank

Water run through the system may damage the injection pump or nozzles. Damage to the fuel system will subsequently cause more expensive damage to the engine. A large accumulation of water in the bottom of the fuel tank will stop a diesel engine. Water should be drained off during scheduled maintenance inspections to prevent breakdowns. Drain the water off after the fuel tank and unit have remained idle for an hour.

1. Place a container under the fuel tank to catch the draining water and fuel.
2. Remove the drain plug from the bottom of the fuel tank.

NOTE: Some fuel tanks have a check valve in the drain plug fitting. Push the check valve open with a small screw driver to drain the tank.

3. Let the water and fuel drain into the container until no water is visible in the fuel draining from the tank. If the water and fuel do not drain freely, the vent may be plugged. If so, clean or replace the vent.
4. Install the drain plug.

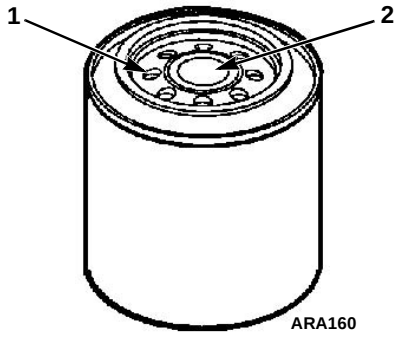
Fuel Filter/Water Separator

The fuel filter/water separator removes water from the fuel and returns it to the fuel tank.

Fuel Filter/Water Separator Replacement

Replace the fuel filter/water separator at intervals according to the Maintenance Inspection Schedule.

1. Unscrew the fuel filter/water separator canister with a strap wrench. Drain, and dispose of properly.
2. Clean the filter head seal surface.
3. Lubricate the canister seal with clean fuel.
4. Through one of the small openings in the top of the canister, fill the new fuel filter/water separator canister with clean fuel. This will purge the air from the canister. Do not fill canister through the center hole.
5. Screw the new canister on hand-tight. Using a strap wrench, tighten another 1/4 turn.



1.	Fill Through Small Opening
2.	Do Not Fill Through Center Hole

Figure 25: Filling Fuel Filter/Water Separator

Engine Speed Adjustments

When the diesel engine fails to maintain the correct engine speed, check the following before adjusting the speed:

1. Check the fuel inlet screen. Check the speed.
2. Bleed the air out of the fuel system. Check the speed.
3. Bleed the air out of the nozzles. Check the speed.

Make the engine speed adjustments with the engine fully warmed up.

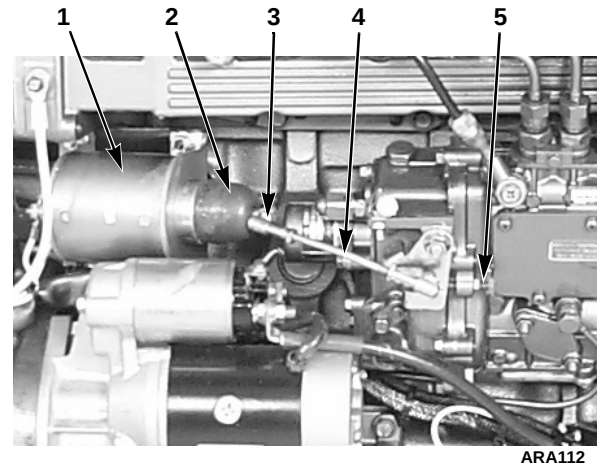
High Speed

1. Use the Service Test Mode to run the unit in high speed and check the high speed rpm. It should be 2200 ± 25 rpm.
2. Shut the unit off.
3. Remove the ball joint from the eye bolt in the high speed solenoid.
4. Remove the boot from the high speed solenoid.
5. Pull the plunger out of the solenoid enough to loosen the jam nut. An Allen wrench placed in the hex opening in the face of the plunger will keep the plunger from turning. Turn the plunger eye bolt clockwise to increase the speed and counterclockwise to decrease the speed.
6. Replace the ball joint, start the unit and check the speed. When the speed is correct, tighten the jam nut and replace the solenoid boot.

NOTE: If the correct speed cannot be set close enough with half turns of the eye bolt, use the Allen wrench to turn the plunger in smaller increments.

Low Speed

1. Loosen the jam nut on the low speed adjustment screw.
2. Use the Service Test Mode to run the unit in low speed. Adjust the screw to obtain the correct speed. It should be 1450 ± 25 rpm.
3. Tighten the jam nut and recheck the speed.



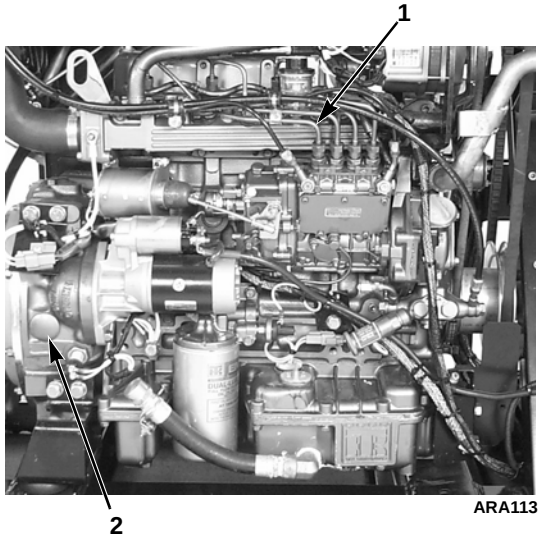
1.	High Speed Solenoid
2.	Boot
3.	Ball Joint
4.	Speed Control Rod
5.	Low Speed Adjustment Screw

Figure 26: Engine Speed Adjustments

Injection Pump Timing

This timing procedure requires fuel pressure at the injection pump inlet. This can be accomplished by pumping the priming pump by hand, or by using an electric fuel pump to supply fuel to the fuel pump inlet.

1. Place the Zone 1 On/Off switch in the Off position.
2. Remove the round cover (plug) from the timing mark access hole on the front of the bell housing. The index marks on either side of this hole and the timing marks on the flywheel are used to check the injection pump timing.



1.	Number One Cylinder Injection Line
2.	Timing Mark Access Hole

Figure 27: Component Location

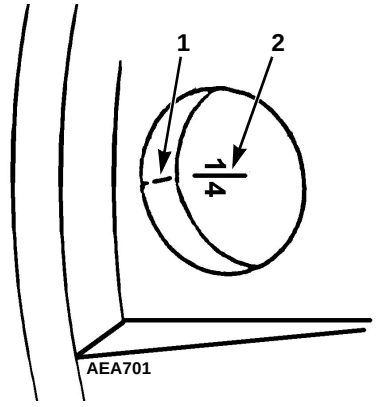
CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.

3. Remove the injection line for the number one cylinder from the delivery valve on the injection pump and from the injection nozzle.

   NOTE: The number one cylinder is the cylinder at the flywheel end of the engine.

4. Remove the rocker arm cover.
5. Place the engine at top dead center of the compression stroke for the number one cylinder. Refer to steps a through d.

   a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the 1-4 timing mark on the flywheel lines up with the index mark in the timing mark access hole.



1.	Index Mark
2.	Top Dead Center Mark for 1 and 4

Figure 28: Top Dead Center One and Four

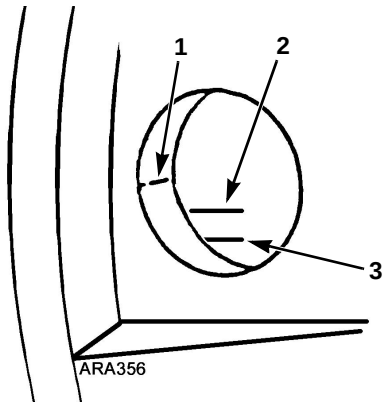
   b. Check the rocker arms on the number one cylinder to see if they are loose.

   c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number one cylinder.

   d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number one cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number one cylinder.

6. Disconnect the 8S wire from the starter solenoid to prevent the engine from cranking when the unit is turned On.
7. Place the Zone 1 On/Off switch in the On position.
8. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Diagnostic Manual for detailed information about the Relay Board Test Mode.

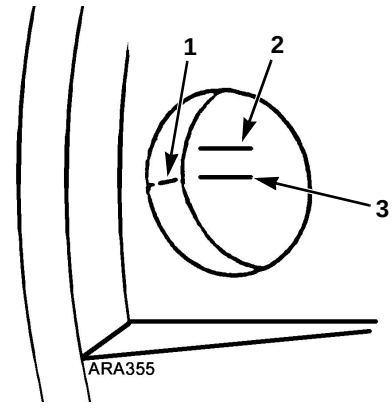
9. Energize the fuel solenoid by energizing the run relay [RUNR] with the Relay Board Test Mode.
10. Rotate the engine backwards (counterclockwise viewed from the water pump end) until the 10 degree BTDC (before top dead center) timing mark is positioned in the bottom of the timing mark access hole. There are two injection timing marks. The 10 degree BTDC timing mark is a horizontal line stamped on the flywheel approximately 1.0 in. (25 mm) before the top dead center mark.The 12 degree BTDC timing mark is a horizontal line stamped on the flywheel approximately 1.2 in. (30 mm) before the top dead center mark.



1.	Index Mark
2.	12 Degree BTDC Timing Mark
3.	10 Degree BTDC Timing Mark

Figure 29: Timing Mark Alignment

11. Pump the priming pump by hand a few times, or energize the electric fuel pump if an electric fuel pump is being used.
12. Use a clean towel to remove the fuel from the top end of the delivery valve holder.
13. Slowly turn the engine in the normal direction of rotation until you see the fuel rise in the end of the delivery valve holder. Stop as soon as you see the fuel rise.
14. Check position of the timing marks. The 10 degree BTDC timing mark on the flywheel should be aligned with the index mark on the side of the timing mark access hole. Repeat steps 10 through 14 to recheck the timing.



1.	Index Mark
2.	12 Degree BTDC Timing Mark
3.	10 Degree BTDC Timing Mark

Figure 30: Correct Injection Timing Mark Alignment

15. If the timing is off by more than 1 degree (0.1 in. [2.5 mm]), loosen the mounting nuts on the studs that fasten the injection pump to the engine and rotate the injection pump to change the timing.
    a. Pull the top of the injection pump away from the engine to advance the timing.
    b. Push the top of the injection pump toward the engine to retard the timing.
16. Tighten the injection pump mounting nuts and recheck the timing. Repeat steps 10 through 16 until the timing is correct.
17. Install the cover in the timing mark access hole, install the injection line for the number one cylinder, install the rocker arm cover, tighten the other injection lines and reconnect the 8S wire to the starter solenoid when finished with the procedure.

Injection Pump Removal

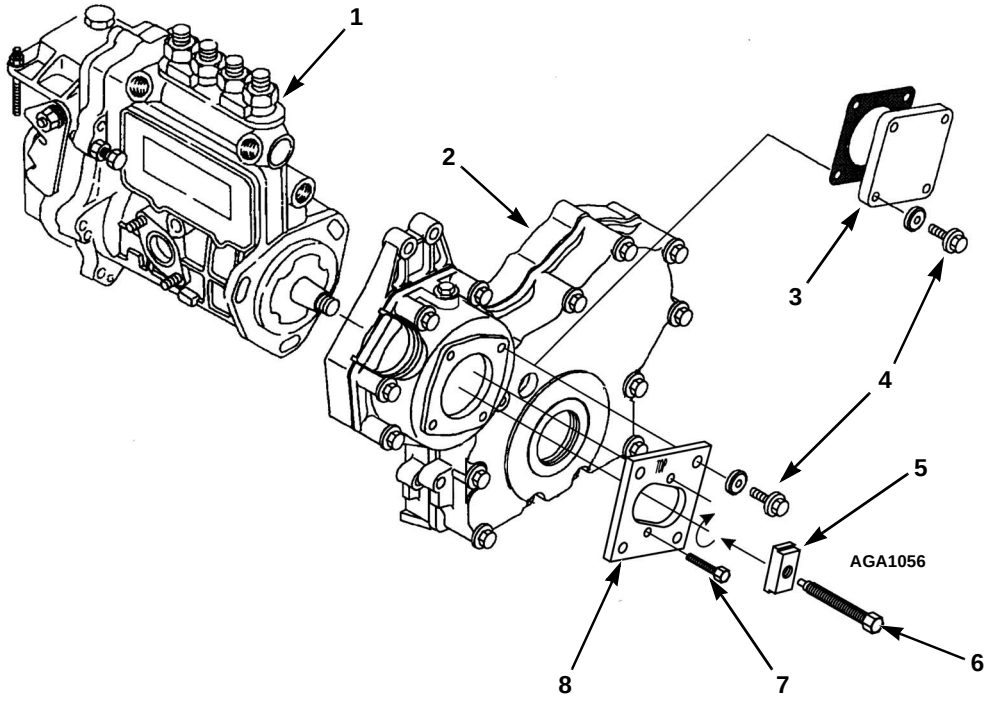
The injection pump drive gear will not fit through the gear housing when removing the pump, the gear must be separated from the pump. Using tool P/N 204-1011, it will not be necessary to remove the belts, fuel pump, crankshaft pulley, crankshaft seal or front plate.

1. Remove the starter for clearance, remove throttle linkage, fuel lines, harness and mounting hardware from injection pump.

2. Remove the cover plate from the gear case. Remove the nut and lock washer which secure the gear to the injection pump shaft. Use a shop rag to prevent the lock washer or nut from falling into the gear case.
3. Use the hardware from the cover plate to attach the tool plate (with the marked side pointing up and out) to the gear case.
4. Align the threaded holes in the injection pump gear with the two holes in the tool plate by rotating the engine crankshaft. Attach the gear to the tool plate with the screws provided with the tool plate.
5. Thread the long screw supplied with the tool plate into the small end of the adapter, also supplied with the tool plate. Insert the adapter into the tool plate and rotate to provide a solid position to force the injection pump shaft from the gear. Caution should be made to align the screw over the center of the injection pump shaft.
6. Remove the screw and adapter leaving the tool plate in place. This holds the gear in proper tooth alignment until the injection pump is re-installed.

Injection Pump Reinstallation

1. Position injection pump shaft into gear, rotating shaft to mate key with keyway in gear.
2. Secure injection pump to gear case with previously removed hardware.
3. Remove hardware holding gear to tool plate, then remove tool plate.
4. Secure gear to injection pump shaft with lock washer and nut, use a shop rag, as before, to prevent the lock washer or nut from falling into the gear case. Torque the nut to 84 to 90 ft-lb (113 to 122 N•m)
5. Fasten cover plate to gear case and reinstall all components removed previously to facilitate injection pump removal.

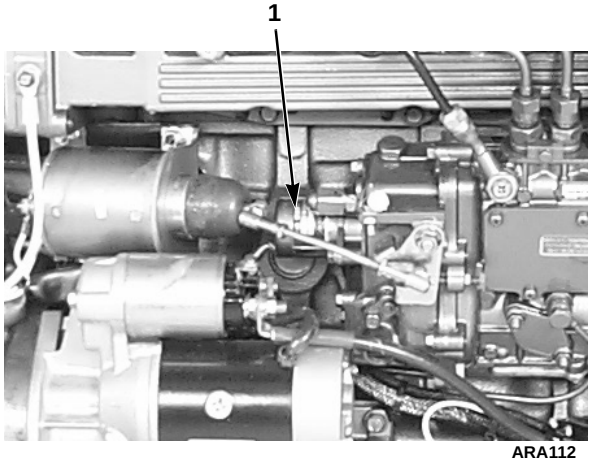


1.	Injection Pump	5.	Adapter
2.	Gear Case	6.	Tool Long Screw
3.	Cover Plate	7.	Tool Short Screw
4.	Cover Plate Bolt	8.	Tool Plate

Figure 31: Injection Pump Gear Tool

Fuel Solenoid System

The fuel solenoid is located on the end of the injection pump. It contains two coils: the pull-in coil, and the hold-in coil. The pull-in coil draws approximately 35 to 45 amps at 12 volts. The hold-in coil draws approximately 0.5 amps at 12 volts.

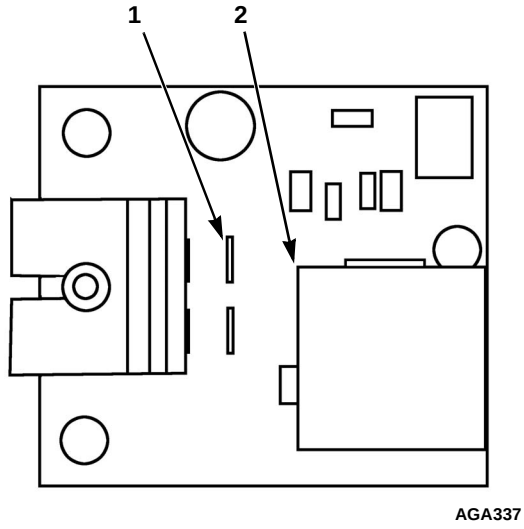


1.	Fuel Solenoid

Figure 32: Fuel Solenoid Location

The pull-in coil must be energized to move the injection pump governor linkage to the fuel on position. Once the injection pump governor linkage has been moved to the fuel on position, the hold-in coil will keep it in fuel on position until the 8D circuit is de-energized. The pull-in coil must be de-energized after a few seconds to keep it from being damaged.

A fuel solenoid timer is used to control the fuel solenoid pull-in coil. The fuel solenoid timer consists of a small PC board that contains some electrical components, a four pin wire connector, and one removable relay. The relay is called the fuel solenoid relay. The fuel solenoid timer is mounted inside the control box.



1.	Four Pin Connector
2.	Fuel Solenoid Relay (FSR)

Figure 33: Fuel Solenoid Timer

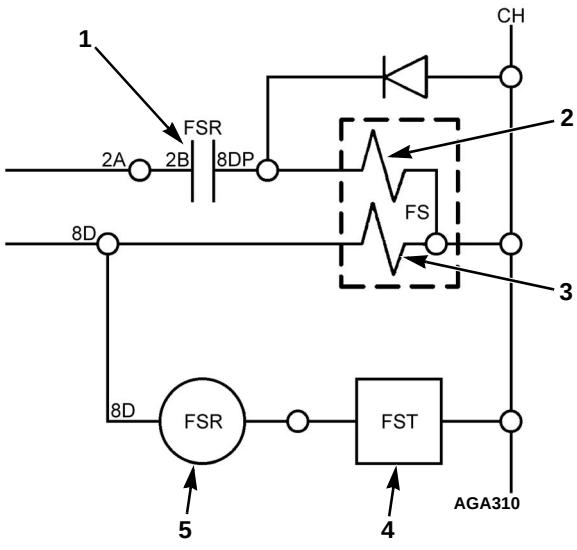
Fuel Solenoid Timer Operation

The fuel solenoid hold-in coil is connected to the 8D circuit. The fuel solenoid relay coil is also connected to the 8D circuit and it is grounded through the fuel solenoid timer. The fuel solenoid pull-in coil is connected to the 2A circuit through the normally open contacts of the fuel solenoid relay when the fuel solenoid relay is energized.

When the 8D circuit is energized, it supplies power to the fuel solenoid hold-in coil and to the fuel solenoid relay coil. The hold-in coil is energized and remains energized as long as there is power on 8D. The fuel solenoid relay is energized momentarily by the fuel solenoid timer when the 8D circuit is first energized. After approximately 2.5 seconds, the fuel solenoid timer de-energizes the fuel solenoid relay by opening the circuit to ground.

During the time the fuel solenoid relay is momentarily energized, the fuel solenoid pull-in coil is energized by the 2A circuit through the normally open contacts of the fuel solenoid relay and the 8DP circuit.

When power is removed from the 8D circuit the fuel solenoid hold-in coil is de-energized, and the fuel solenoid resets.



1.	Fuel Solenoid Relay Contacts
2.	Fuel Solenoid Pull-In Coil
3.	Fuel Solenoid Hold-In Coil
4.	Fuel Solenoid Timer
5.	Fuel Solenoid Relay Coil

Figure 34: Simplified Schematic Diagram of Fuel Solenoid System

Troubleshooting the Fuel Solenoid System

NOTE: The fuel solenoid pull-in coil will require 35 to 45 amps to turn on the fuel. The unit's battery must be in good condition. If the battery has enough power to crank the engine over, it has enough power to energize the fuel solenoid pull-in coil.

If you suspect that the engine does not run because the fuel solenoid is not operating correctly, use the following procedure:

1. Disconnect the fuel solenoid wire connector from the main wire harness.
2. Use the microprocessor keypad to enter the Relay Board Test Mode. Refer to the appropriate Microprocessor Operation and Diagnosis Manual for detailed information about the Relay Board Test Mode.
3. Energize the fuel solenoid circuits by energizing the run relay [RUNR] with the Relay Board Test Mode.
4. Check the voltage on the 8D circuit (pin A) in the main wire harness connector for the fuel solenoid. Refer to the following illustrations to identify the pins in the wire connectors.
   a. If battery voltage is not present on the 8D circuit, check the 8D circuit and the related circuits and components for a fault.
   b. If battery voltage is present on the 8D circuit, go to step 5.

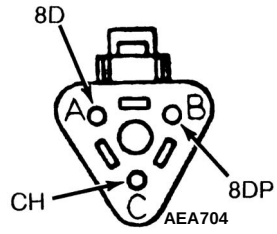
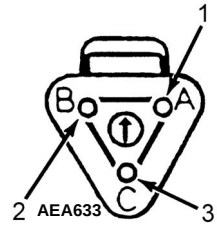


Figure 35: Main Wire Harness Connector Pin Identification



1.	Red (8D)
2.	White (8DP)
3.	Black (CH)

Figure 36: Fuel Solenoid Connector Pin Identification

5. Check the CH circuit (pin C) in the main wire harness connector for continuity to a good chassis ground.
   a. If there is no continuity between the CH circuit and a good chassis ground, check the CH wire for an open circuit.
   b. If there is continuity between the CH circuit in the main wire harness at the fuel solenoid wire connector and a good chassis ground, go to step 6.
6. Place a jumper wire between the black wire (CH—pin C) in the fuel solenoid connector and a good chassis ground.

7. Test the pull-in coil by momentarily placing a jumper between the white wire (8DP—pin B) in the fuel solenoid connector and the positive battery terminal. The fuel solenoid should make a definite click when the pull-in coil is energized and should click again when the pull-in coil is de-energized.

   NOTE: The pull-in coil will draw 35 to 45 amps so do not leave the jumper connected to the white wire (8DP—pin B) for more than a few seconds.

   a. If the pull-in coil does not energize, check the resistance of the pull-in coil by placing an ohmmeter between the white wire (8DP—pin B) and the black wire (CH—pin C) in the fuel solenoid connector. The resistance of the pull-in coil should be 0.2 to 0.3 ohms. If the resistance of the pull-in coil is not in this range, replace the fuel solenoid.

   NOTE: If the pull-in coil fails, make sure to replace the fuel solenoid relay with relay P/N 41-478. This particular relay is needed for the high current flow through the hold-in coil.

   b. If the pull-in coil does energize, go to step 8.

8. Test the hold-in coil.

   a. Energize the hold-in coil by placing a jumper between the red wire (8D—pin A) in the fuel solenoid connector and the positive battery terminal.

   b. Momentarily energize the pull-in coil by placing a jumper between the white wire (8DP—pin B) in the fuel solenoid connector and the positive battery terminal. The fuel solenoid should make a definite click when the pull-in coil is energized, but should not click when the pull-in coil is de-energized.

   c. De-energize the hold-in coil by removing the jumper from the red wire (8D—pin A) and the positive battery terminal. The fuel solenoid should make a definite click when the hold-in coil is de-energized.

   d. If the hold-in coil does not function properly, check the resistance of the hold-in coil by placing an ohmmeter between the red wire (8D—pin A) and the black wire (CH—pin C) in the fuel solenoid connector. The resistance of the hold-in coil should be 24 to 29 ohms. If the resistance of the hold-in coil is not in this range, replace the fuel solenoid.

   e. If the hold-in coil does function properly, go to step 9.

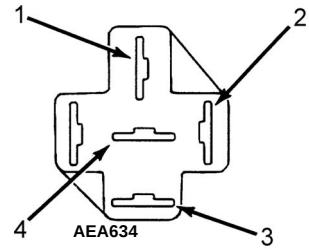
9. Reconnect the fuel solenoid connector and the main wire harness connector.

10. Remove the fuel solenoid relay from its socket and make sure the Zone 1 On/Off switch is in the On position and the unit is in the Relay Board Test Mode [RUNR].

11. Check the voltage on the 8D circuit at the 85 terminal in the fuel solenoid relay socket. Refer to the following illustration to identify the terminals in the relay socket.

    a. If battery voltage is not present on the 8D circuit, check the 8D circuit and the related circuits and components for a fault (minimum voltage is 10 volts).

    b. If battery voltage is present on the 8D circuit, go to step 12.



1.	30 Terminal—2B Circuit
2.	85 Terminal—8D Wire
3.	87 Terminal—8DP Wire
4.	86 Terminal to Capacitor and Diode

Figure 37: Relay Socket Terminal Identification

12. Check the voltage on the 2A circuit at the 30 terminal in the fuel solenoid relay socket.

    a. If voltage is not present on the 2A circuit, check the 2A circuit for an open or a short.

b. If battery voltage is present on the 2A circuit, go to step 13.

13. Test the relay.

a. Use a jumper to connect the 85 terminal on the relay to the positive battery terminal.

b. Use another jumper to connect the 86 terminal on the relay to a CH circuit.

c. If the relay does not energize, it is defective. Replace the relay.

d. If the relay does energize, the timer is defective. Replace the fuel solenoid timer PC board.

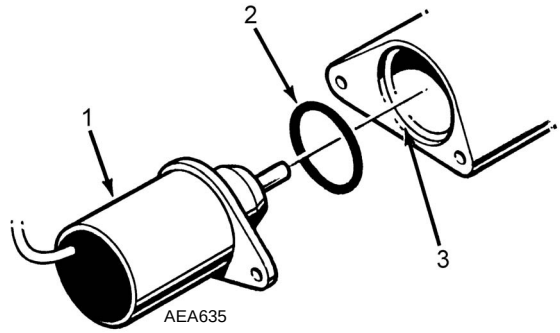
14. Turn the unit Off after completing the test procedure.

Fuel Solenoid Replacement

1. Disconnect the fuel solenoid wire connector from the main wire harness and remove the old fuel solenoid.
2. Connect the new fuel solenoid wire connector to the main wire harness.
3. Place the Zone 1 On/Off switch in the On position.
4. Use the Multi-Temp µP-IV microprocessor keypad to enter the Relay Board Test mode. Refer to the appropriate Microprocessor Operation and Diagnosis Manual for specific information about the Relay Board Test mode.
5. Energize the fuel solenoid by energizing the run relay [RUNR] with the Relay Board Test mode.

   NOTE: The fuel solenoid must be energized when it is being installed. If it is not, the plunger and the linkage may not line up correctly and the fuel solenoid will not function properly.

6. Place the o-ring in the groove in the end of the fuel injection pump. Make sure that the o-ring is positioned correctly during installation to avoid damage and leaks.
7. Install the new fuel solenoid.
8. Place the Zone 1 On/Off switch in the Off position after installing the fuel solenoid.



1.	Fuel Solenoid
2.	O-ring
3.	Groove in Fuel Injection Pump

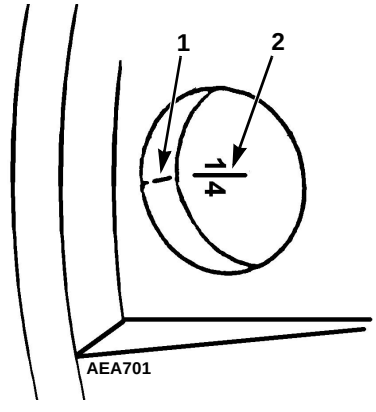
Figure 38: Fuel Solenoid Components

Engine Valve Clearance Adjustment

1. Remove the rocker arm cover.
2. Remove the round cover (plug) from the timing mark access hole on the front of the bell housing.

CAUTION: Loosen all of the injection lines at the injection nozzles to prevent the possibility of the engine firing while it is being rotated.

3. Place the engine at top dead center of the compression stroke for the number one cylinder. See steps a through d.



1.	Index Mark
2.	Top Dead Center Mark for 1 and 4

Figure 39: Top Dead Center One and Four

a. Rotate the engine in the normal direction of rotation (clockwise viewed from the water pump end) until the 1-4 timing mark on the flywheel lines up with the index mark in the timing mark access hole.

b. Check the rocker arms on the number one cylinder to see if they are loose.

c. If the rocker arms are loose, the engine is at top dead center of the compression stroke for the number one cylinder.

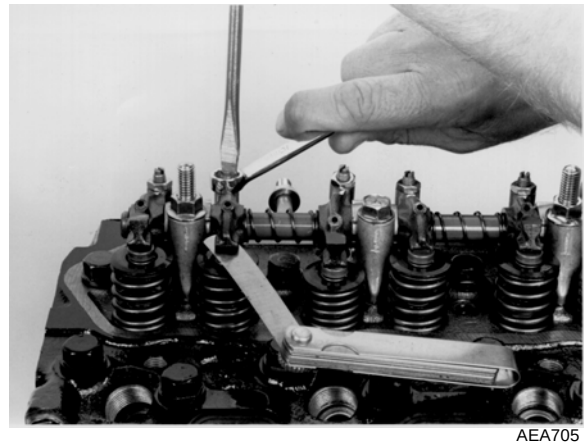
d. If the rocker arms are tight, the engine is at top dead center of the exhaust stroke for the number one cylinder. Rotate the engine 360 degrees to place the engine at top dead center of the compression stroke for the number one cylinder.

4. Use a feeler gauge to check the valve clearance on both valves for the number one cylinder, the intake valve for the number two cylinder, and the exhaust valve for the number three cylinder. The valve clearance for both the intake valve and the exhaust valve should be 0.006 to 0.010 in. (0.15 to 0.25 mm).

   NOTE: Check to make sure that the valve stem cap is in good condition and is positioned squarely on the top of the valve stem. Replace the valve stem cap if it shows significant wear.

5. Adjust the valves if necessary by loosening the locknut and turning the adjustment screw until the valve clearance is correct.

6. Hold the adjustment screw in place and tighten the locknut.



AEA705

Figure 40: Adjusting the Valve Clearance

7. Recheck the valve clearance.

8. Rotate the engine one full turn (360 degrees) in the normal direction of rotation (clockwise viewed from the water pump end), and align the 1-4 timing mark on the flywheel with the index mark in the timing mark access hole. This is top dead center of the compression stroke for the number four cylinder.

9. Check and adjust the exhaust valve for the number two cylinder, the intake valve for the number three cylinder, and both valves for the number four cylinder.

10. Replace the rocker arm cover, the cover for the timing mark access hole, and tighten the fuel injection lines when finished.

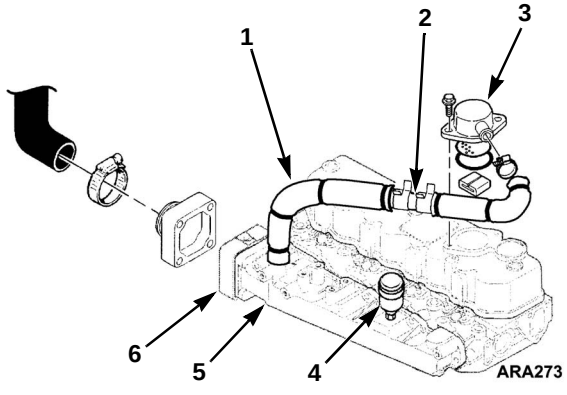
Valve Adjustments and Cylinder Configurations								
	Front						Rear	
Cylinder Number	**1**		**2**		**3**		**4**	
Valve arrangement	E	I	E	I	E	I	E	I
Piston in No. 1 cylinder is at TDC on compression stroke	○	○		○	○			
Piston in No. 4 cylinder is at TDC on compression stroke			◎			◎	◎	◎

Crankcase Breather

The crankcase breather is located on top of the rocker arm cover. The crankcase breather system ducts crankcase gases formed in the crankcase directly to the air intake. Harmful vapors that would otherwise collect in the crankcase and contaminate the oil, or escape to the outside, are drawn back into the engine and burned. A restrictor is placed in the breather hose to limit the flow gas flow from the crankcase to the intake and keep the crankcase pressure from getting too low.

Normal crankcase pressures with a new air cleaner are 5 to 10 in. (127 to 254 mm) H_2O of vacuum at 1450 rpm and 7 to 11 in. (178 to 279 mm) H_2O of vacuum at 2200 rpm. The vacuum will increase as the air cleaner gets dirty and becomes more restrictive. The crankcase breather and the breather hose should be inspected when the air cleaner element is replaced to make sure they are not plugged or damaged.

NOTE: The breather hose must be routed so it slopes down from the crankcase breather to the intake manifold. This prevents condensation from collecting in the breather hose. The condensation can plug the breather hose if it collects and freezes in the hose.



1.	Insulation (Covers breather Hose to prevent freezing.)
2.	Restrictor
3.	Crankcase Breather
4.	Air Restriction Indicator
5.	Intake Manifold
6.	Intake Air Heater

Figure 41: Crankcase Breather

Air Cleaner

Before the first quarter of 2001, a heavy duty, dry element air cleaner was used on this unit. Replace this air cleaner when the air restriction indicator reads 25 in. of vacuum.

EMI 3000 Air Cleaner

The EMI 3000 air cleaner is a dry element air cleaner. It became standard equipment on this unit in the first quarter of 2001. Replace the EMI 3000 air cleaner element when the air restriction indicator reads 25 in. of vacuum, or at 3,000 hours or 2 years, whichever occurs first. The EMI 3000 air cleaner element has a nameplate that reads “EMI 3000.” It cannot be interchanged with air cleaners used on previous units, however it can be retrofit on previous units by using the EMI 3000 Air Cleaner Assembly and the related components.

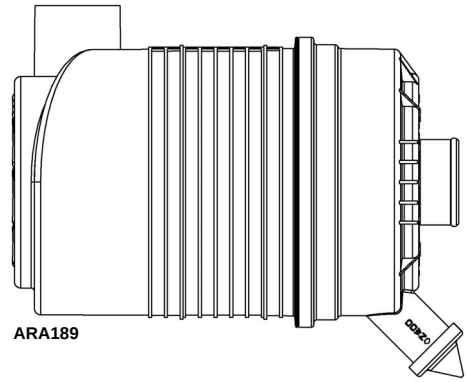
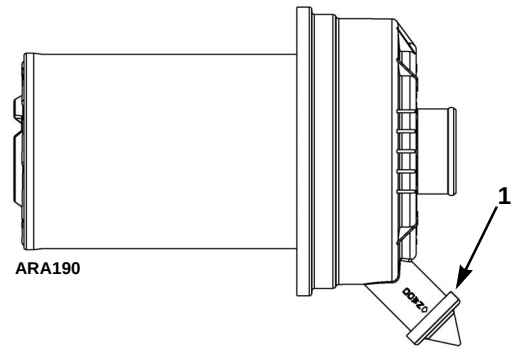
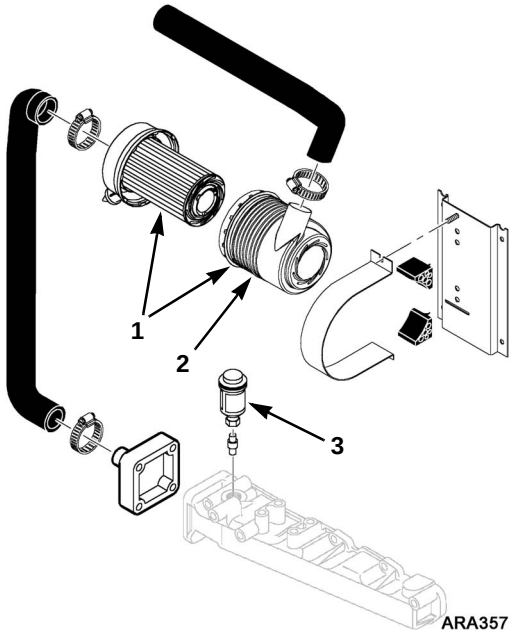


Figure 42: EMI 3000 Air Cleaner Assembly



1.	Dust Ejector Must Point Down When Installed

Figure 43: EMI 3000 Air Filter Element



1.	EMI 3000 Air Cleaner Assembly
2.	EMI 3000 Air Filter Element
3.	Air Restriction Indicator

Figure 44: EMI 3000 Air Cleaner System

Air Restriction Indicator

Excessive restriction of the air intake system reduces the flow of air to the engine affecting horsepower output, fuel consumption and engine life.

An air restriction indicator is installed on the air intake manifold. Visually inspect the restriction indicator periodically to assure the air filter is not restricted. Service the air filter when the yellow diaphragm indicates 25 in. of vacuum. Press the reset button on the top of the air restriction indicator after servicing the air filter.

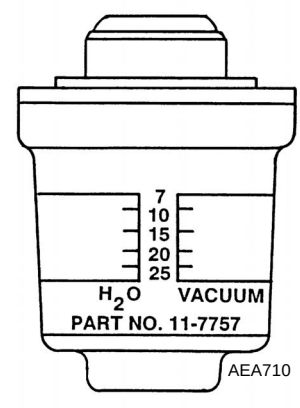


Figure 45: Air Restriction Indicator

Belts

Belts should be regularly inspected during unit pretrip inspections for wear, scuffing or cracking. Belt tension should also be checked during scheduled maintenance inspections. Belts that are too loose will whip and belts that are too tight put too much strain on the belt fibers and bearings.

Using belt tension gauge, P/N 204-427, is the best method of checking belts for tightness. Install the belt gauge in the center of the longest belt span. Press the plunger so the hook will engage the belt. Make sure the hook is on the face of the belt, not in a notch. Release the plunger with a quick motion and without pulling on the belt. Then read the dial. Use an average of three readings.

NOTE: Do not attempt to remove or install belts without loosening adjustments. Belts that are installed by prying over pulleys will fail prematurely due to internal cord damage.

CAUTION: Do not attempt to adjust belts with the unit running.

CAUTION: With the unit On/Off switch in the On position, the unit may start operation at any time without prior warning. Switch the unit On/Off switch to the Off position before performing maintenance or repair procedures.

Belt Adjustments

Alternator Belt Adjustment

The alternator belt tension should read 67 on the belt tension gauge.

1. Loosen the alternator pivot bolt and the adjusting arm bolt.
2. Move the alternator on the adjusting arm slots to adjust the belt to 67 on the belt tension gauge.
3. Tighten the adjusting arm bolt and alternator pivot bolt.

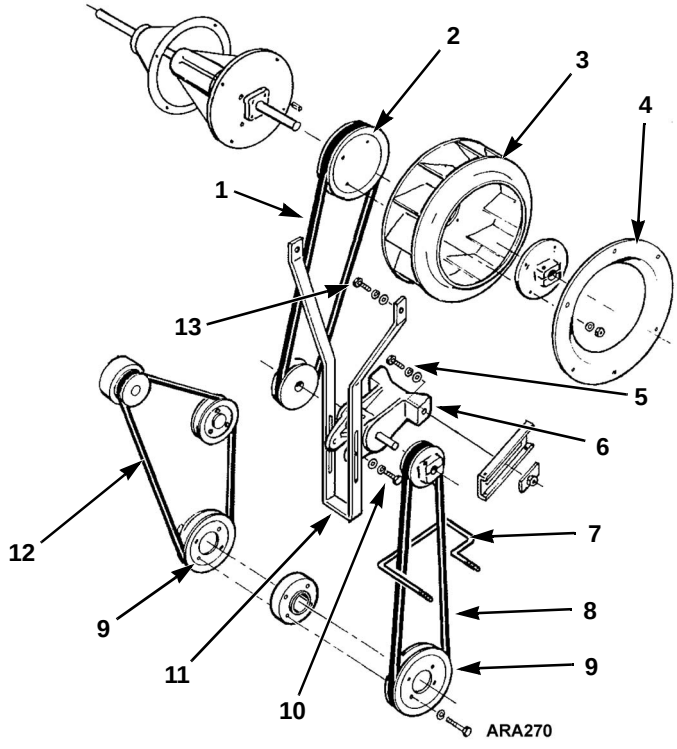
Upper and Lower Fan Belt Adjustment

The upper fan belt should read 74 and the lower fan belt should read 67 on the belt tension gauge.

NOTE: Both the upper and lower fan belts are adjusted at the same time in one procedure.

NOTE: If a fan belt is loose or damaged, replace the belt (see "Fan Belt Replacement" on page 69).

1. Loosen the idler assembly pivot bolts and the idler adjusting arm bolts.
2. Push in or pull out on the idler adjusting arm to "center" the idler assembly between the belts and balance the tension equally between the upper and lower belts.



1.	Upper Fan Belt	8.	Lower Fan Belt
2.	Condenser Fan Pulley	9.	Engine Pulley
3.	Condenser Fan	10.	Idler Adjusting Arm Bolt
4.	Condenser Inlet Ring	11.	Idler Adjusting Arm
5.	Idler Assembly Pivot Bolt	12.	Alternator Belt
6.	Idler Assembly	13.	Idler Adjusting Arm Pivot Bolt
7.	Belt Guide		

Figure 46: Model 30 Belt Arrangement

3. Tighten both idler adjusting arm bolts and both idler assembly pivot bolts.

   NOTE: If the idler assembly binds when moving for belt adjustment, loosen the upper idler support bracket mounting bolts to free up the assembly. Check the main idler retainer nut assembly for proper alignment between the nut and the support bracket slots.

Fan Belt Replacement

NOTE: Do not attempt to remove or install the belts without loosening the adjustments. Belts that are installed by prying over pulleys will fail prematurely due to internal cord damage.

Lower Fan Belt

Removal

1. Loosen both idler adjusting arm bolts and both idler pulley assembly bolts.
2. Push the idler adjusting arm IN. The lower fan belt will come off the engine pulley. Move the arm OUT far enough to clear the roadside idler mounting bracket.

Installation

1. Slip the belt into the groove of the idler pulley.
2. Push the idler adjusting arm back in toward the unit.
3. Slip the belt onto the pulley groove on the engine.
4. Pull the idler adjusting arm back *out* and adjust the belts to the proper tension.
5. Tighten the idler assembly pivot bolts and the idler adjusting arm bolts.

Upper Fan Belt

Removal

1. Loosen the idler adjusting arm bolts and remove the lower fan belt (see “Lower Fan Belt” above).
2. Push the idler adjusting arm in and the idler assembly up. The upper belt should become slack and slip down out of the idler pulley groove.
3. Pull the idler adjusting arm OUT. The upper fan belt should slip off the idler pulley as the idler pulley hub clears the curbside idler mounting bracket.
4. Loosen the two condenser fan hub to the shaft clamping bolts.
5. Tap the blower wheel with a soft hammer to drive the blower wheel up the fan shaft to provide 1/2 in. (13 mm) clearance between the blower wheel and the inlet ring.

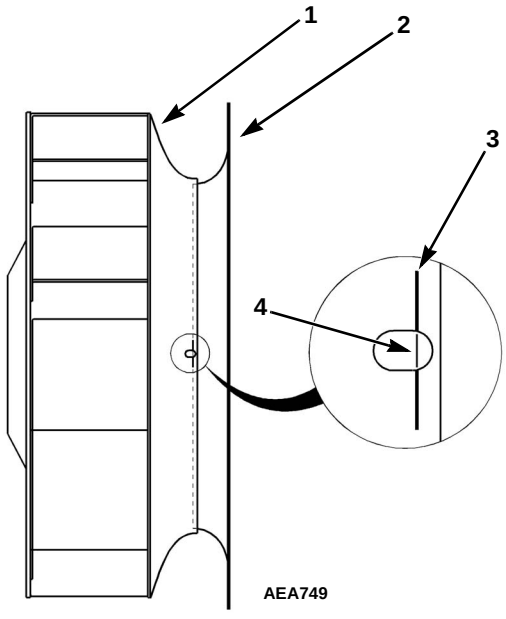
   NOTE: If the condenser fan does not slide on the fan shaft with light tapping, remove the small access panel located on the condenser coil header above the radiator tank. Thread a 1/4-20 x 1 in. diameter bolt into the end of the fan shaft. Tighten the bolt and washer down on the condenser fan hub to loosen the blower wheel. Drive the blower wheel back to provide 1/2 in. (13 mm) clearance between the blower wheel and condenser fan inlet ring.

6. Lift the belt up over the condenser blower wheel and remove it from the unit.

Installation

1. Slip the belt over the condenser blower wheel and place it in the condenser fan pulley.
2. Drive the condenser blower wheel out toward the condenser fan inlet ring using a soft hammer.
3. Position the blower wheel so the edge of the inlet ring lines up with the alignment mark on the blower wheel.
4. Check the radial clearance between the blower wheel and inlet ring with a gauge wire. Check around the entire circumference to the inlet ring and blower wheel (see “Condenser and Evaporator Fan Location” on page 100).
5. Torque the blower hub clamping bolts to 18 ft-lb (24 N•m).
6. Seat the upper belt in the blower wheel pulley groove.
7. Push inward on the idler adjusting arm and slip the belt into the idler pulley groove.

8. Pull the idler adjusting arm forward and install the lower fan belt.



1.	Blower Wheel
2.	Inlet Ring
3.	Alignment Mark
4.	Edge of Inlet Ring

Figure 47: Condenser Blower Alignment

Refrigeration Maintenance

NOTE: The following procedures involve servicing the refrigeration system. Some of these service procedures are regulated by Federal, and in some cases, by State and Local laws.

In the USA all regulated refrigeration service procedures must be performed by an EPA certified technician, using approved equipment and complying with all Federal, State and Local laws.

Refrigerant Charge

Testing the Refrigerant Charge with an Empty Trailer

If the unit has an insufficient charge of refrigerant, the evaporators will be "starved" and the box temperatures will rise even though the unit is operating. The suction pressure will drop as the refrigerant charge decreases. If the unit has an overcharge of refrigerant, the unit may not cool properly and the suction and discharge pressure may be high. The charge may be determined by inspection of the refrigerant through the receiver tank sight glass with the following conditions established:

1. Place a test box over each evaporator.
2. Install a gauge manifold.
3. Run all the evaporators on cool until the return air temperature in each box is at 0 F (-18 C). By allowing a box to leak a small amount, you will be able to maintain 0 F (-18 C).
4. The suction pressure should be 13 to 18 psig (90 to 124 kPa).
5. The discharge pressure should be 325 to 400 psig (2241 to 2758 kPa). If the pressure is below this, it can be raised by covering a portion of the roadside condenser grille with a piece of cardboard to block condenser airflow.
6. Under these conditions, the ball should be floating in the receiver tank sight glass. If refrigerant is not visible in the receiver tank sight glass, the unit is low on refrigerant.

Testing the Refrigerant Charge with a Loaded Trailer

NOTE: This test determines if there is enough refrigerant for the current temperatures, not if there is a full charge of refrigerant.

1. Install a gauge manifold.
2. Run all the evaporators on cool.
3. Build up and maintain 325 to 400 psig (2241 to 2758 kPa) of discharge pressure. If the pressure is below this, it can be raised by covering the roadside condenser grille with a piece of cardboard to block condenser air flow.
4. Cool the compartments to lowest temperatures required.
5. Check suction pressure. It should be 13 to 22 psig (90 to 152 kPa).
6. Under these conditions, the ball should be floating in the receiver tank sight glass. If refrigerant is not visible in the sight glass, the unit is low on refrigerant.

Testing for an Overcharge

Use the following procedure to identify a unit with an excessive refrigerant charge:

1. Install a gauge manifold on the compressor.
2. Operate the host unit in high speed with all the evaporators in cool to stabilize system pressures and reduce the compartment temperatures to approximately 60 F (16 C) or colder.
3. Observe discharge pressure and cover the condenser to increase the discharge pressure approximately 50 psig (345 kPa) above the observed pressure. Do not allow the discharge pressure to go above 350 psig (2413 kPa).

   NOTE: If the ball and liquid level in the receiver sight glass drops during step 3, the unit is not overcharged and it is not necessary to complete the procedure.
4. Remove the condenser cover to rapidly reduce discharge pressure.

5. Observe the receiver tank sight glass and the unit's discharge pressure.
6. By the time the discharge pressure drops approximately 50 psig (345 kPa) the ball in the receiver tank sight glass should begin to move and the liquid level should drop.
   a. When discharge pressure stabilizes, the ball and liquid level will rise.
   b. If the ball will not begin to move or the liquid level will not drop, the unit most likely has an overcharge of refrigerant. The refrigerant level should be adjusted.

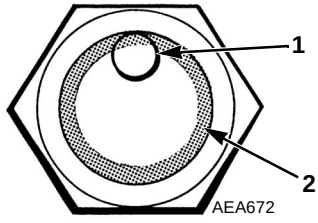
Adjusting Refrigerant Level

1. Stop the unit and remove some refrigerant with an approved refrigerant recovery device.
2. Perform a refrigerant level check and repeat the overcharge test.
3. If the liquid level is low, add refrigerant as follows:
   a. Connect a refrigerant tank to the gauge manifold service line and purge the line.
   b. Mid seat the suction service valve.
   c. Set the refrigerant tank for liquid removal and open the hand valve.
   d. Operate the unit in high speed with all evaporators in cool.
   e. Observe the suction pressure and slowly open the gauge manifold low pressure hand valve to allow liquid refrigerant to flow into the suction service valve.
   f. Control the liquid flow so the suction pressure increases approximately 20 psig (138 kPa).
   g. Maintain a discharge pressure of at least 325 to 400 psig (2241 to 2758 kPa) while adding refrigerant.
   h. Close the hand valve on the refrigerant tank when liquid appears in the receiver sight glass.
4. Repeat the overcharge test.
5. Remove the gauge manifold set and cap all service ports and valve stems when the refrigerant level is correct.

Moisture Indicating Sight Glass

The receiver tank is equipped with a moisture indicating sight glass. The outer edge of the sight glass has a colored ring approximately 0.1 in. (2.5 mm) thick. The color of the ring indicates the moisture content of the refrigerant, but it may not be completely reliable.

- Green = Dry
- Chartreuse = Caution
- Yellow = Wet



1.	Floating Ball
2.	Colored Ring

Figure 48: Moisture Indicating Sight Glass

A system has to run for at least 15 minutes to change the color of the indicator ring after the moisture content of the system has been changed. For example, evacuating a system to remove the moisture will not change the color of the indicator ring until the system has been recharged and then operated for at least 15 minutes.

Refrigerant Leaks

Use a reliable leak detector that is suitable for R-404A to leak test the refrigeration system. Inspect for signs of oil leakage which is the first sign of a leak in the refrigeration system.

Compressor Sump Sizes

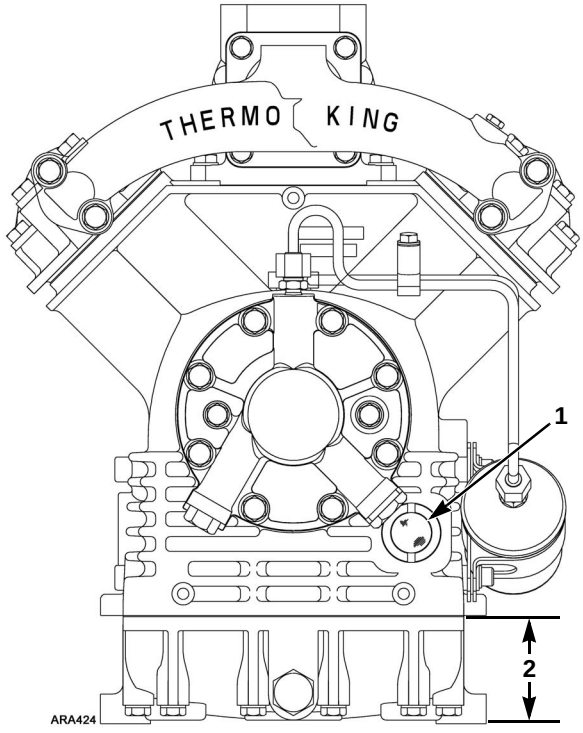
Units built before mid-February 2003 are equipped with compressors that have a 4-quart sump.

Units built after mid-February 2003 are equipped with compressors that have a 7-quart sump.

Identification

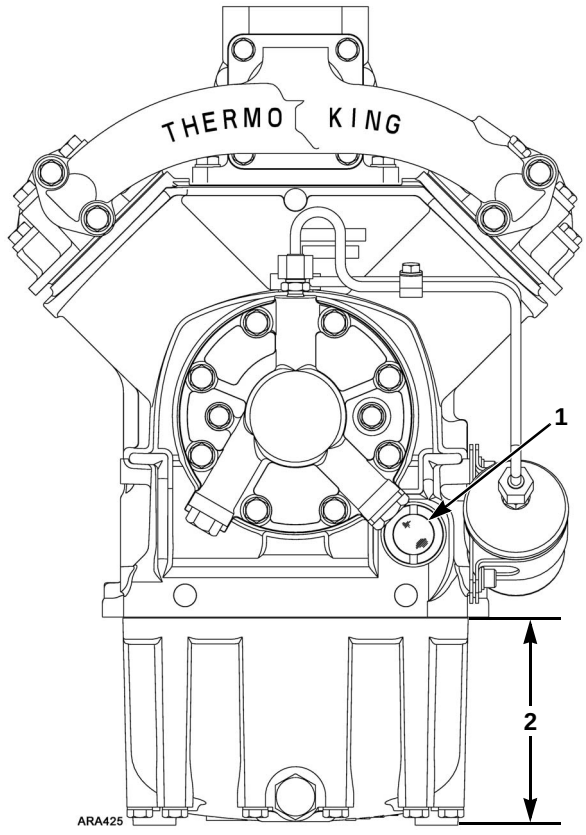
The 4-quart sump measures 2.67 in. (68 mm) from the bottom of the sump to the top of its gasket surface.

The 7-quart sump measures 5.35 in. (136 mm) from the bottom of the sump to the top of its gasket surface.



1.	Sight Glass
2.	Sump Height 2.67 in. (68 mm)

Figure 49: Compressor with 4-Quart Sump



1.	Sight Glass
2.	Sump Height 5.35 in. (136 mm)

Figure 50: Compressor with 7-Quart Sump

Compressor Oil Level

The recommended compressor oil level is the same for both compressors. The sight glass should be 1/4 to 1/2 full. See “Checking Compressor Oil” on page 74. See the Specifications Chapter for the total quantity of compressor oil.

Compatibility

The 7-quart sump compressor and the 4-quart sump compressor are interchangeable. However, the increased oil capacity of the 7-quart sump improves long-term reliability.

Compressor Removal and Installation

The 7-quart sump extends below the top of the lower frame rails. Therefore, a flat board cannot be used as a support when removing or installing a compressor with a 7-quart sump. A Compressor Installation Tool P/N 204-1087 (two pieces) has been developed to aid in the removal and installation of the 7-quart sump compressor. See Compressor Removal and Installation on pages 79 and 80 for more information.

Compressor Disassembly and Assembly

All compressor repair procedures and torque specifications are the same for the 7-quart sump compressor as for the 4-quart sump compressor. See the X214, X418, X426 & X430 Compressor Overhaul Manual TK 6875 for complete details.

Compressor Conversion

A 4-quart sump compressor can be converted to a 7-quart sump compressor. The following parts must be replaced:

Description	P/N	Qty
Sump Oil Machined 7 Quart	22-1181	1
Tube/Screen Oil Pickup 7 Quart	22-1182	1
Bracket Pickup Tube	92-2921	1
Gasket Sump 7 Quart	33-3797	1
Screw HH 3/8-16 x 5.5 Inch SZN	51-0575	16

IMPORTANT: The sump gasket for the 4-quart sump is different and must not be used with the 7-quart sump.

Checking Compressor Oil

The compressor oil should be checked when there is evidence of oil loss (oil leaks) or when components in the refrigeration system have been removed for service or replacement. Use the compressor sight glass to check the oil level. See Figure 49 or Figure 50 on page 73.

To check compressor oil level with an ambient air temperature above 50 F (10 C):

Install a gauge manifold on the compressor.

Operate all the evaporators on cool with a 20 psig (138 kPa) minimum suction pressure and a 185 psig (1275 kPa) minimum discharge pressure for 15 minutes or more.

After the unit has maintained the above conditions for 15 minutes, observe the oil level. The oil should be 1/4 to 1/2 up in the sight glass.

To check compressor oil level with an ambient air temperature below 50 F (10 C):

Run all the evaporators through a complete defrost cycle. After completing the defrost cycles, run all the evaporators on cool for ten minutes. Observe the oil level. The oil should be 1/4 to 1/2 up in the sight glass.

If the compartment is empty, you can run the evaporator on the heat cycle instead of the defrost cycle.

NOTE: Use refrigeration compressor oil ONLY. Polyol Ester type (P/N 203-513) is required on R-404A systems.

High Pressure Cutout Switch (HPCO)

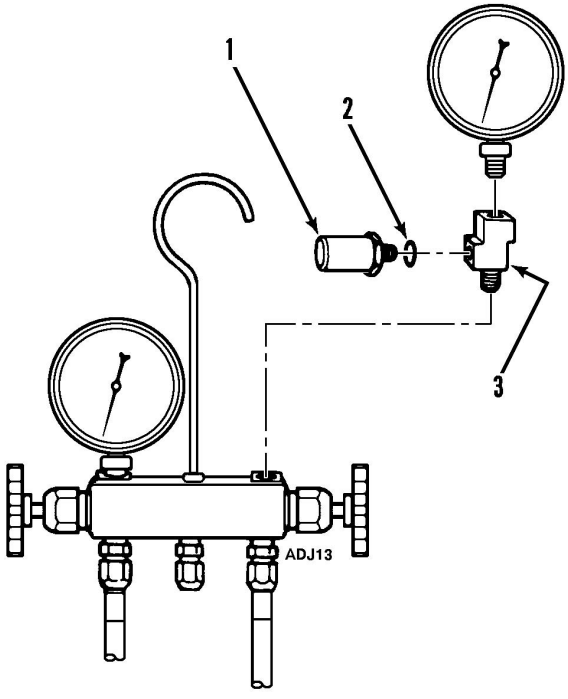
The HPCO is located on the compressor discharge manifold. If the discharge pressure rises above 470 psig (3241 kPa), the HPCO opens. This opens the 8P-8D circuit, which de-energizes the fuel solenoid and shuts down the unit. The microprocessor then records Alarm Code 10. To test the HPCO; rework a gauge manifold. See Figure 51 on page 75.

1. Connect the gauge manifold to the compressor discharge service valve with a heavy duty, black jacketed thick wall #HCA 144 hose with a 900 psig (6204 kPa) working pressure rating.
2. Use the Service Test mode to run the host unit in High Speed Cool. Refer to the appropriate Diagnosis Manual for specific information about the Service Test Mode.

3. Raise the discharge pressure of the compressor by covering the roadside condenser grille with apiece of cardboard to block the condenser coil air flow. The microprocessor will shift the engine to low speed when the discharge pressure rises to approximately 400 psi (2758 kPa). Increase the engine speed by overriding the throttle solenoid. This should increase the discharge pressure enough to cause the HPCO to cut out. The cut out pressure should be 470 ± 7 psig (3241 ± 48 kPa).

CAUTION: If the discharge pressure reaches 477 psig (3289 kPa), shut the unit off immediately. Do not allow the discharge pressure to exceed 477 psig (3289 kPa).

4. If the HPCO does not open to de-energize the fuel solenoid and stop the engine, it must be replaced.



1.	Relief Valve (66-6543)
2.	O-Ring (33-1015)
3.	Adapter Tee Weather Head (No. 552X3)

Figure 51: High Pressure Cutout Manifold

High Pressure Switch (HPSW) Test

The high pressure switch (HPSW) is located on the compressor discharge manifold. This switch is used by the microprocessor to confirm the operation of the receiver tank pressure solenoid and the purge valve. It is connected to the 7K1 and HP wires in the main wire harness. The HPSW opens when the discharge pressure rises above 300 psig (2068 kPa). The HPSW closes when the discharge pressure drops below 200 psig (1379 kPa).

Use the following procedure to test the HPSW:

1. Install a gauge manifold on the compressor.
2. Disconnect the HPSW from the 7K1 and HP wires in the main wire harness.
3. Check the HPSW for continuity. It should be closed when the unit is not running.
4. Use the Service Test mode to run the host unit in High Speed Cool. Refer to the appropriate Diagnosis Manual for specific information about the Service Test Mode.
5. Cover the condenser to raise the discharge pressure.
6. Monitor the discharge pressure. When the discharge pressure reaches 300 +25/-0 psig (2068 +172/-0 kPa), the HPCI should open.
7. Uncover the condenser to lower the discharge pressure.
8. Monitor the discharge and suction pressures. When the discharge pressure reaches 200 ± 20 psig (1379 ± 138 kPa), the HPSW should close.
9. Replace the HSW if it does not function properly.
10. Reconnect the HPSW to the main wire harness and remove the gauge manifold.

Evacuating and Charging Smart Reefer Multi-Temp Systems

Set-up Unit

The Smart Reefer Multi-Temp µP-IV microprocessor must be placed in the Evacuation Mode to evacuate and charge the unit. When the microprocessor is in the Evacuation mode it opens all the solenoid valves in the refrigeration system. This allows the refrigeration system to be evacuated properly. Refer to the appropriate Diagnosis Manual for complete information about the microprocessor. Use the following procedure to set-up the unit and the place the microprocessor in the Evacuation mode:

1. Connect a battery charger to the unit battery. The battery charge must have an output of at least 15 amperes. This will maintain the charge level of the battery during the time required to evacuate and the charge the unit. The microprocessor's Service Test mode is used to open unit valves as required for evacuation. Failure to connect a battery charger may result in the battery voltage falling too low to reliably operate the microprocessor and valves.
2. Use the CYCLE-SENTRY Selection screen to select Continuous Run operation if Continuous Run operation is not already selected.
3. Place the Zone 1 On/Off switch in the Off position.
4. Place the Zone 1, Zone 2, and Zone 3 On/Off switches in the On position.
5. Clear any alarm codes using the **CODE** and **CLEAR** keys.
6. With the standard screen on the display and before the engine starts, press the **TK** key and hold it down (for 3 to 5 seconds) until [PrE] [TRIP] appears on the display.
7. Press the **SELECT** key. If [OFF] and [PRNT] appear on the display, press the **SELECT** key again. The letters [REV] should appear in the lower display and the revision number should appear in the upper display.
8. With the revision screen on the display, press both the **TK** key and the **CLEAR** key and hold them down (for 3 to 5 seconds) until [TEST] and [VAC] appears on the display.
9. Press the **ENTER** key to load the Evacuation mode [VAC]. All normally closed valves will be energized.

   The display should show [TEST] and [VAC].

   If the display shows [SET] and [VAC], a higher rate of battery charge is required. Alarm Code 109 will be generated. This is normal.
10. The microprocessor is now in the Evacuation mode. The refrigeration system is set-up for evacuation and charging.

Evacuating the System

1. Be sure all refrigerant has been recovered from the unit.
2. Connect a vacuum pump and gauge manifold for 3 point evacuation to the suction service valve, discharge service valve, and receiver tank outlet valve.

   NOTE: The use of the Thermo King Evacuation Station P/N 204-725 or 204-744 is recommended.
3. Verify proper operation of the Evacuation Station as shown in the Evacuation Station Operation Manual TK 40612.
4. Start the evacuation pump and mid-seat the suction service valve, discharge service valve, and receiver tank outlet valves.
5. Install service valve stem caps with seals and tighten them. The valve stems should remain capped while evacuating the unit.
6. Evacuate the unit to 500 microns.
7. Continue to evacuate the unit for one additional hour after reaching 500 microns. This insures complete evacuation of the remote evaporators and lines.
8. Close the Evacuation Station valve nearest the vacuum pump (V1) to isolate the vacuum pump from the system. Turn the vacuum pump off.

9. Observe the vacuum gauge.

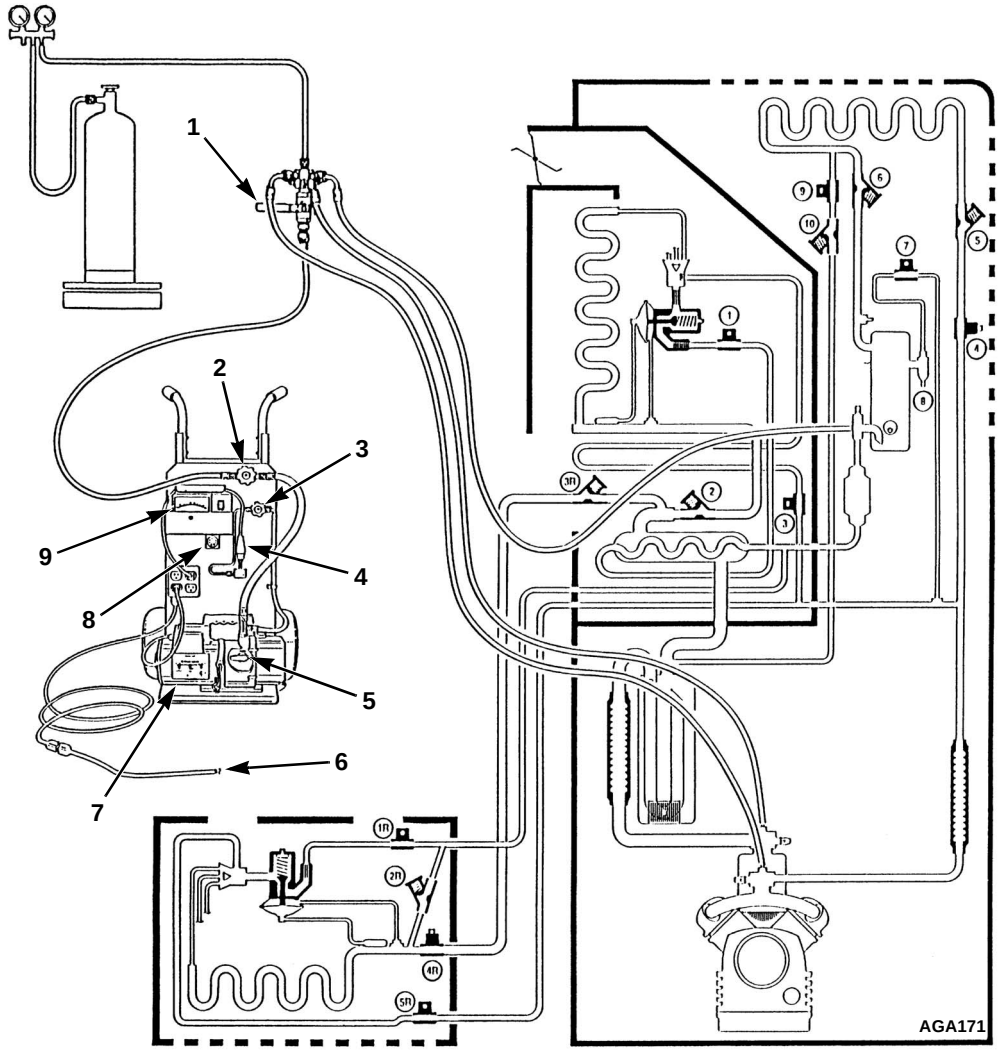
   The system pressure should remain below 2000 microns for 5 minutes.

   If the pressure does not hold check for leaks (if a leak is suspected) or continue evacuation (if system is not dry).

10. Restart the pump, open the Evacuation Station valve nearest the pump (V1) and repeat steps 6, 8, and 9 as required until system pressure remains below 2000 microns for 5 minutes.

11. When system pressure remains below 2000 microns for 5 minutes, restart the pump, open the Evacuation Station valve nearest the pump and back seat the suction service valve while the evacuation pump is still operating. Replace the valve cap, re-close the Evacuation Station valve nearest the pump (V1) and stop the evacuation pump.

Do not exercise the service valves with the unit in a deep vacuum unless the evacuation pump is operating.



1.	V-4	6.	To AC Power
2.	V-3	7.	Two Stage Pump
3.	V-2	8.	Calibration Standard
4.	Thermistor	9.	Vacuum or Micron Gauge
5.	V-1		

Figure 52: Multi-Temp Evacuation and Charging (Two Zone Unit Shown Other Units Similar)

Charging the System

1. Insure that all compartment bulkheads are open. Ceiling mounted bulkheads should not be stored close to the evaporator outlets as this will restrict airflow.
2. Determine the correct charge for the unit as configured. The actual weight of the charge may vary somewhat due to length of refrigerant lines.
3. The unit should still be in Evacuation mode. Add as much of the charge as possible as liquid through the discharge service valve and receiver tank outlet valve.
4. Back seat and crack the discharge service valve.
5. Back seat the receiver tank outlet valve.
6. Crack the suction service valve.
7. Exit the Evacuation mode by turning the Zone1/Host On/Off switch Off, and then back On.
8. Turn all zones On and set all zone setpoints for the lowest possible temperature to insure that all zones run in Cool mode. Allow the unit to start.
9. Cover the condenser as required to maintain discharge pressure from 325 to 400 psig (2241 to 2758 kPa) and add the remaining charge by weight as liquid through the suction service valve.
10. If necessary, continue to add refrigerant until the ball in the receiver tank sight glass is floating but is no higher than 1/2 way up the glass. If they system is overcharged, remove refrigerant until the ball in the receiver tank sight glass is floating but is no higher than 1/2 way up the glass.
11. Continue to operate the unit and monitor the sight glass until all compartment temperatures are at or below 0 F (-18 C).
12. If the receiver tank sight glass level drops, add additional refrigerant as required to maintain refrigerant in the bottom 1/2 of the sight glass.
13. When refrigerant level is correct back seat all service valves, remove the gauge manifold, and securely replace valve stem covers with seals and service port caps before returning the unit to service.

NOTE: It is generally good practice to replace the filter drier whenever the high side is opened or when the low side is opened for an extended period of time.

Low Side Pump Down

NOTE: Operate all the evaporators in Cool for 2 to 5 minutes with the service valves in their normal operating positions before performing the low side pump down. Install a gauge manifold at the compressor.

1. Run all the evaporators in cool, front seat the receiver tank outlet valve and the bypass hand valve, and pump down the low side to 20 to 25 in. Hg vacuum (-68 to -85 kPa). Turn the Zone 1 On/Off switch Off.

   If the unit pumps down acceptably and then holds at least 15 in. Hg vacuum (-51 kPa) for 2 minutes or more, it can be assumed that the receiver tank outlet valve, the compressor discharge valve plates, the HGS solenoid, the HGS2 solenoid, the HGS3 solenoid, and the purge valve solenoid are sealing acceptably.

2. Prepare to perform service on the unit's low side by equalizing the high side and low side pressures.

   a. Disconnect the purge valve solenoid wires from the main wire harness.

   NOTE: If the purge valve solenoid wires are not disconnected from the main wire harness, the purge valve is energized when the unit is placed in the Evacuation mode. This allows the refrigerant in the condenser to flow into the accumulator, undoing the low side pump down.

   b. Place the unit in the Evacuation mode. Refer to the Service Test mode in the appropriate Microprocessor Diagnosis Manual. The high and low side pressures should equalize in the Evacuation mode.

   NOTE: Repeat the pump down procedure if the pressures equalize above 20 psi (138 kPa). If suitably low pressures cannot be achieved after the third pump down, the refrigerant must be recovered to perform service on the low side.

   c. If the reading on the gauge manifold's high pressure gauge increases after the high and low side pressures have been equalized, the condenser inlet check valve is leaking.

   d. Remember to reconnect the purge valve solenoid wires to the main wire harness when the service procedures have been completed.

Compressor

The 7-quart sump extends below the top of the lower frame rails. Therefore, a flat board cannot be used as a support when removing or installing a compressor with a 7-quart sump. A Compressor Installation Tool P/N 204-1087 (two pieces) has been developed to aid in the removal and installation of the 7-quart sump compressors.

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Remove the remaining refrigerant pressure from the compressor.
3. Unbolt the discharge and suction service valves from the compressor.
4. Remove the compressor oil filter and its lines.
5. Disconnect the HPCO wires and the HPSW wires.

6. Support the compressor and remove the compressor mounting bolts from the flywheel housing. For a compressor with a 7-quart sump use The Compressor Installation Tool (P/N 204-1087) to support the compressor as follows:
    a. Identify the four machined feet on the base of the compressor sump. The Compressor Installation Tools bridge the lower frame rails and support the compressor directly under these feet.
    b. Position the Compressor Installation Tools by inserting them from the end of the compressor and sliding them into place on the lower frame rails. Alternatively, position the Compressor Installation Tools by inserting them on a diagonal from below the compressor and twisting them into position over the lower frame rails.
7. Lift the service valves out of the way.
8. Slide the compressor to the left until the coupling pins are clear.
9. Remove the compressor from the front of the unit. Keep the compressor ports covered to prevent dust, dirt, etc., from falling into the compressor.

    NOTE: When the compressor is removed from the unit, the oil level should be noted, or the oil removed from the compressor should be measured so that the same amount of oil can be added before placing the replacement compressor in the unit.

Installation

1. If installing a 7-quart sump compressor, place the Compressor Installation Tools on the lower frame rails to support the compressor.
2. Slide the compressor into the unit.
3. Place the compressor in position and install the mounting bolts.
4. Install the service valves using new gaskets soaked in compressor oil. Connect the HPCO wires, the HPSW wires, and install the compressor oil filter.
5. Pressurize the compressor and test for refrigerant leaks.
6. If no leaks are found, evacuate the compressor.
7. Back seat the suction and discharge service valves.
8. Operate the unit at least 30 minutes and then inspect the oil level in the compressor. Add or remove oil if necessary.
9. Check the refrigerant charge and add refrigerant if needed.

Compressor Coupling Removal

1. After the compressor has been removed from the unit, use the appropriate Allen tool provided with removal tool P/N 204-991 (see Figure 53 on page 81) to loosen the center bolt, which holds the coupling to the compressor shaft.
2. Attach the tool to the coupling with the provided socket head screws and spacers. Two sets of spacers are provided with the tool, use the short spacers with shallow compressor mounting flanges and the longer set for deeper flanges. The side with the countersunk holes should be toward the coupling.
3. To prevent the tool and crankshaft from rotating, use one of the compressor to engine mounting screws to pin the tool to the flange. If a nut is used to prevent the bolt from falling out, the nut should not be tightened.
4. Use the appropriate Allen tool to loosen the coupling mounting screw.
5. Once the center screw has been loosened, back the head against the tool and it should push the coupling off the crankshaft as you continuing turning the center screw in a counter-clockwise direction. Using this tool will prevent the coupling from popping off because the center bolt and flatwasher will hold it in place.

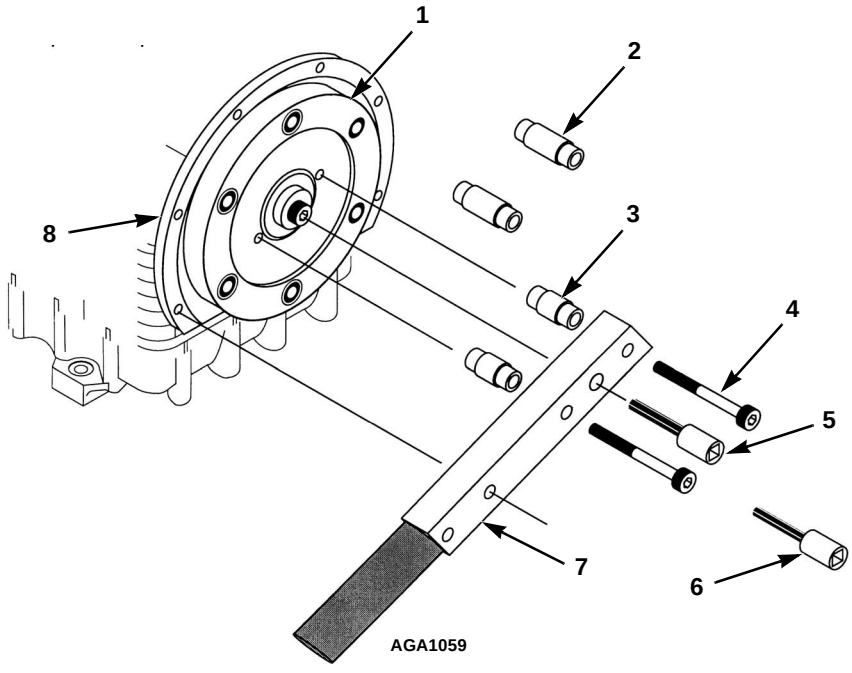
Compressor Coupling Installation

In a tapered fit joint the entire twisting load should be handled by the friction fit between the two tapered parts. The key is only a backup and is used to index the parts correctly. When a taper fit is machined and assembled properly a key is not needed. In fact, if the key is not installed correctly it may be worse than no key at all! If the key does not fit easily into the keyway, it will push the tapered components apart and the reduced friction could lead to slippage and premature failure.

The following procedure requires the key to be fitted after the tapers are pulled together with 20 ft-lb (27 N•m) torque. This insures that the key cannot hold the tapers apart when the final bolt torque is applied.

Use the following procedure to install a compressor coupling on the compressor crankshaft.

1. Clean the compressor shaft taper and coupling bore taper with a solvent that leaves no oily residue (such as naphtha, lacquer thinner, brake cleaner or the like).
2. Inspect both mating surfaces for burrs, oxidation and other surface imperfections. Dress with crocus cloth if necessary and re-clean as required.



1.	Coupling	5.	10 mm Allen Tool (for large shaft compressor)
2.	Long Spacers (supplied with tool)	6.	5/16 Allen Tool (for small shaft compressors)
3.	Short Spacers (supplied with tool)	7.	Coupling Removal Tool (P/N 204-991)
4.	Socket Head Bolts (supplied with Tool)	8.	Engine Mounting Flange

Figure 53: Compressor Coupling Removal Tool

3. **Using no lubricants**, set the coupling on the crankshaft and align the keyways using the Keyway Tool (P/N 204-972). Insert the tapered end of the tool into the keyway and gently move the coupling on the shaft while pressing the tool into the keyway. This will align the keyway in the crankshaft with the keyway in the coupler.

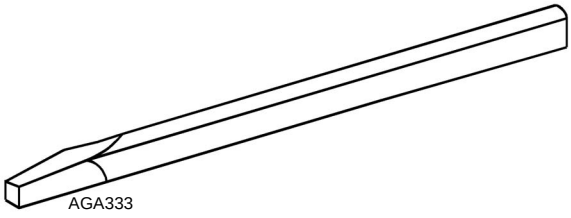
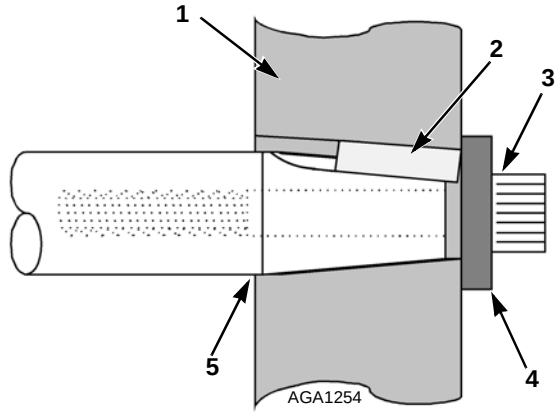


Figure 54: Keyway Tool P/N 204-972

CAUTION: If you are assembling a used coupler or crankshaft and the tool does not fit easily there is a problem with one of the keyways! Do not remove the coupler and place the key in the crankshaft keyway and then drop the coupler on. If the tool does not fit, the key will not fit, and it will hold the taper in the coupler off the taper on the shaft. Check both keyways for burrs or corrosion. A key can be coated with fine lapping compound and used as a lapping tool to clean the keyways.

4. Remove the Keyway Tool and check the fit of the key (P/N 55-9024). It should fit into the keyway with a light press fit requiring only a minimum of light tapping. If the key does not fit properly, remove the coupler and inspect the keyways and key for burrs or other problems. Recheck the fit as shown above.
5. When the key fits properly, remove the coupling and key from the shaft.
6. Re-install the coupling and align the keyways with the Keyway Tool.
7. **Do not install the key at this time.** Install the flat washer and bolt and pre-torque to 20 ft-lb (27 N•m). Remove the bolt and washer.
8. Install the key in the keyway. As above, it should fit with a light press fit requiring only a minimum of light tapping. **Do not install the key into the keyway beyond the front face of the coupling.** If tapped in farther it may cause the coupling to move off center on the shaft.



1.	Compressor Coupling or Clutch
2.	Key tapped flush with outside face of coupling. Do not tap key any farther into keyway.
3.	Torque bolt to 90 ft-lb (122 N•m)
4.	Washer
5.	Spray this area with corrosion inhibitor after assembling.

Figure 55: Compressor Coupling Installation

9. Re-install the bolt and heavy flat washer and snug the bolt down by hand. Torque the bolt to 90 ft-lb (122 N•m).
10. Spray a corrosion inhibitor (such as spray paint) on the exposed part of the shaft and the joint between the shaft and the coupling. This prevents moisture from wicking into the joint and causing corrosion.

Condenser Coil

Removal

1. Recover the refrigerant charge.
2. Drain engine coolant from the expansion tank. Unbolt and remove the coolant expansion tank from the condenser coil frame. Unsolder the tank breather tube.

3. Remove the condenser coil mounting bolts. Remove the mounting clamps from the condenser inlet line.
4. Unsolder the inlet line and liquid line connections. Lift the coil from the unit.

Installation

1. Clean the fittings for soldering.
2. Place the coil in the unit and install the mounting bolts.
3. Solder the inlet line and liquid line connections.
4. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
5. Install the clamps on the condenser inlet line.
6. Install the engine coolant expansion tank and refill half way with engine coolant.
7. Recharge the unit with proper refrigerant and check the compressor oil.

Discharge Vibrasorber

Removal

1. Recover the refrigerant charge.
2. Heat the connections on the vibrasorber until the vibrasorber can be removed.

CAUTION: Use a heat sink, P/N 204-584 or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.

Installation

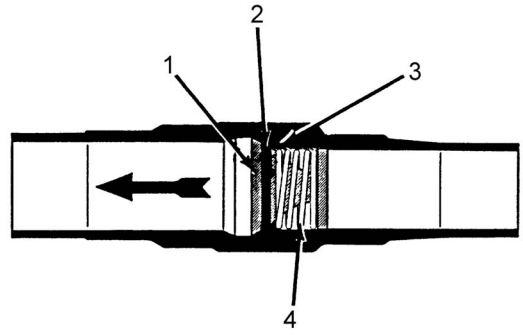
1. Prepare the vibrasorber and tubing fittings by cleaning thoroughly.
2. Solder the vibrasorber connections.

CAUTION: Use a heat sink, P/N 204-584 or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.

3. Pressurize the system and test for leaks. If no leaks are found, evacuate the system.
4. Charge the unit with the proper refrigerant and check the compressor oil level.

In-Line Check Valves

This unit uses some in-line check valves. An in-line check valve is not repairable and must be replaced if it fails. A heat sink must be used on the in-line check valve when it is being soldered in place to prevent damage to the neoprene seal.



1.	Valve
2.	Neoprene Seal
3.	Valve Seat
4.	Spring

Figure 56: Cross Section of In-line Check Valve

Removal

1. Recover the refrigerant charge.
2. Place a heat sink on the check valve.
3. Unsolder the lines and remove the check valve.

Installation

NOTE: A heat sink must be used on the in-line check valve when it is being soldered in place to prevent damage to the neoprene seal.

1. Clean the tubes for soldering.
2. Place the check valve in position. The arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Place a heat sink on the check valve.
4. Solder the inlet and outlet connections.
5. Pressurize the refrigeration system and test for leaks.
6. If no leaks are found, evacuate the system.
7. Recharge the unit with proper refrigerant and check the compressor oil.

Receiver Tank

Removal

1. Recover the refrigerant charge.
2. Unsolder the refrigeration lines from the receiver tank.
3. Unbolt the mounting brackets and remove the receiver tank from the unit.
4. Remove the high pressure relief valve from the receiver tank. It will be installed on the new receiver tank.

Installation

1. Install the high pressure relief valve on the new receiver tank. Make sure to use a new O-ring and coated with refrigerant oil.
2. Place the receiver tank in the unit and install the mounting bolts and nuts loosely. Position the receiver tank so that the sight glass is clearly visible.
3. Solder the refrigeration lines to the receiver tank.
4. Tighten the receiver tank mounting hardware securely.
5. Pressurize the refrigeration system and check for leaks. If no leaks are found, evacuate the system.
6. Recharge the unit with proper refrigerant.

Filter Drier

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Disconnect the ORS nuts at the ends of the drier.
3. Loosen the mounting hardware and remove the drier.

Installation

1. Place the new O-rings in the ORS fittings on the ends of the drier.
2. Install the new drier and tighten the mounting screws and nuts.
3. Install and tighten the inlet ORS nut. Hold the drier with a back-up wrench on the hex behind the ORS fitting.
4. Release a small amount of refrigerant to purge the air through the drier. Then tighten the outlet ORS nut.
5. Pressurize the system and inspect for leaks. If no leaks are found, open the refrigeration valves and place the unit in operation.

Expansion Valve Assembly

NOTE: This procedure applies to the Zone 1 and Zone 2 expansion valves.

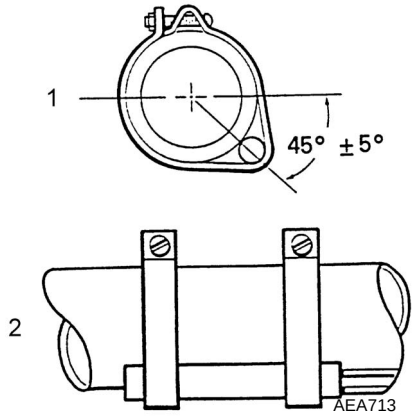
Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the evaporator access panels.
3. Remove the feeler bulb from the clamp. Note the position of the feeler bulb on the suction line.
4. Disconnect the equalizer line from the suction line.
5. Disconnect the inlet liquid line and unsolder the distributor from the expansion valve.
6. Remove the expansion valve mounting bolt and remove the expansion valve from the unit.

Installation

1. Install and bolt the expansion valve assembly in the unit.
2. Connect the inlet liquid line and solder the distributor to the expansion valve.
3. Connect the equalizer line to the suction line.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and the feeler bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or operation will be faulty. Wrap with insulating tape.

5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Replace the access panels.
7. Open the refrigeration valves and place the unit in operation.
8. Test the unit to see that the expansion valve is properly installed.



1.	End View
2.	Side View

Figure 57: Location of Expansion Valve Bulb

Heat Exchanger

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the evaporator access panels.
3. Remove the hardware that holds the heat exchanger on the bulkhead.
4. Unsolder the liquid lines.
5. Unsolder the suction inlet line.
6. Unsolder the remaining outlet suction line connection from the condenser side of the bulkhead. Remove any putty from around the lines before unsoldering the connections.
7. Slide the heat exchanger assembly out of the evaporator housing.

Installation

1. Clean the tubes for soldering.
2. Place the heat exchanger assembly in the evaporator housing and install the mounting hardware loosely.
3. Solder the suction outlet line connection on the condenser side of the bulkhead. Seal the openings through the bulkhead with putty when the refrigerant lines have cooled off.
4. Solder the suction inlet line connection.
5. Solder the liquid line connections.
6. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
7. Tighten the heat exchanger mounting hardware securely.
8. Replace the evaporator access panels.
9. Open the refrigeration valves and place the unit in operation.

Evaporator Coil

NOTE: This procedure applies to the Zone 1 and Zone 2 evaporator coils.

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the evaporator access panels and damper assembly.
3. Disconnect and remove the sensors.
4. Remove the feeler bulb from the suction line clamp. Note the position of the feeler bulb on the suction line.
5. Unsolder the distributor from the expansion valve.
6. Unsolder the hot gas line and the suction line from the evaporator coil.

   NOTE: It may be necessary to unsolder and remove other refrigeration tubes to remove the control box side DE evaporator coil.
7. Remove the mounting bolts, lift and slide the coil from the housing.

Installation

1. Place the evaporator coil in the evaporator housing and install the mounting bolts.
2. Solder the hot gas line and suction line connections to the evaporator coil.

   NOTE: Replace any other refrigeration tubes that were removed.
3. Solder the distributor to the expansion valve.
4. Replace and connect the sensors.
5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Clean the suction line to a bright polished condition. Install the feeler bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or operation will be faulty. Wrap with insulating tape.
7. Replace the upper and lower evaporator access panels.
8. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and compressor oil. Add as required.

Accumulator

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Unsolder the inlet and outlet suction lines from the accumulator.

   CAUTION: Use a heat sink or wrap vibrasorber with wet rags to prevent damaging the vibrasorber.
3. Unbolt and remove the accumulator from the unit.

Installation

1. Place the accumulator in the unit and tighten the mounting bolts and nuts.
2. Solder the inlet and outlet suction lines to the accumulator.

   CAUTION: Use a heat sink or wrap vibrasorber with wet rags to prevent damaging the vibrasorber.
3. Pressurize the low side and test for refrigerant leaks. If no leaks are found, evacuate the low side.
4. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and the compressor oil, and add as required.

Suction Vibrasorber

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Unsolder the suction vibrasorber from the suction service valve.
3. Unsolder the connection to the accumulator and remove the vibrasorber from the unit.

   CAUTION: Use a heat sink or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.

Installation

1. Prepare the suction vibrasorber and tube fittings for soldering by cleaning thoroughly.
2. Solder the vibrasorber to the suction service valve.

   CAUTION: Use a heat sink or wrap the vibrasorber with wet rags to prevent damaging the vibrasorber.
3. Solder the suction hose connection to the accumulator.
4. Pressurize the low side and check for leaks. If no leaks are found, evacuate the system.
5. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and the compressor oil, and add as required.

High Pressure Cutout Switch and High Pressure Switch

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Remove the remaining refrigerant from the compressor.
3. Disconnect the wires and remove the switch from the compressor discharge manifold.

Installation

1. Apply a refrigerant Loctite to the threads of the switch.
2. Install and tighten the switch and reconnect the wires.
3. Pressurize the compressor and test for leaks.
4. If no leaks are found, open the refrigeration service valves and place the unit in operation. Check the refrigerant charge and the compressor oil, and add as required.

Discharge Pressure Sensor

Removal

1. Recover the refrigerant charge.
2. Disconnect the wire connector from the discharge pressure sensor.
3. Remove the mounting clamp (if used) from the discharge pressure sensor.
4. Unscrew the discharge pressure sensor from the adapter on the end of the tube. Use a backup wrench to hold the adapter.
5. Remove the discharge pressure sensor.

Installation

1. Apply refrigerant Loctite to the threads on the discharge pressure sensor.
2. Screw the discharge pressure sensor into the adapter on the end of the tube. Use a backup wrench to hold the adapter.
3. Install the mounting clamp (if used) for the discharge pressure sensor.
4. Recharge the unit with the proper refrigerant and check the compressor oil.

High Pressure Relief Valve

Removal

1. Recover the refrigerant charge.
2. Unscrew and remove the high pressure relief valve. It is located near the top of the receiver tank.

Installation

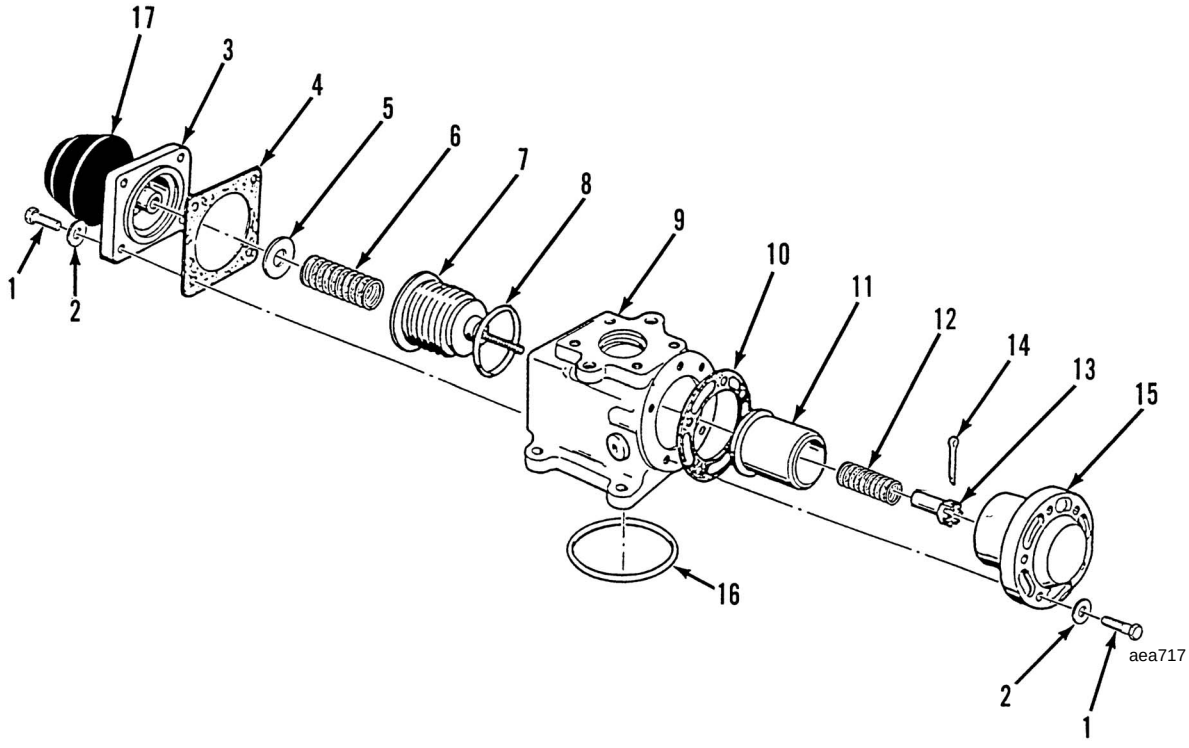
1. Apply a refrigerant oil to the O-ring of the high pressure relief valve.
2. Install and tighten the high pressure relief valve.
3. Pressurize the refrigeration system and test for leaks. If no leaks are found, evacuate the system.
4. Recharge the unit with the proper refrigerant and check the compressor coil.

Throttling Valve

See Figure 58 on page 88 for an illustration of the throttling valve assembly.

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Recover the refrigerant remaining in the compressor.
3. Remove the suction service valve.
4. Unbolt and remove the throttling valve from the unit.



1.	Screw - mtg plate	10.	Gasket - piston housing
2.	Flatwasher	11.	Piston
3.	Plate - bellows end	12.	Spring - piston
4.	Gasket - end plate	13.	Nut - adjusting
5.	Washer - adjusting	14.	Pin - cotter
6.	Spring - bellows	15.	Housing - piston
7.	Bellows & Shaft - assy	16.	O-ring - valve to compressor
8.	O-ring	17.	Cap - rubber
9.	Housing		

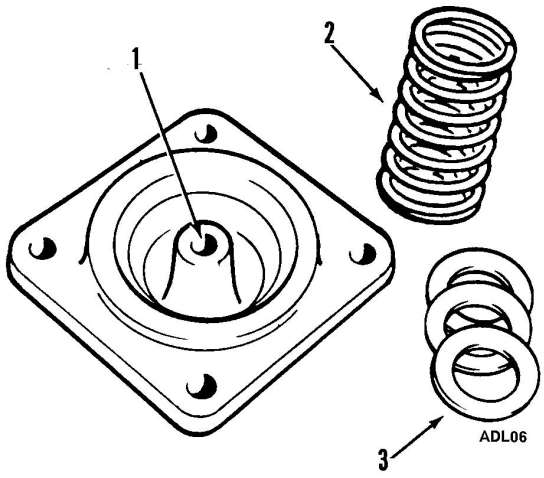
Figure 58: Throttling Valve Assembly

Disassembly

1. Remove the piston end cap (round end).
2. Remove the cotter pin from the castle nut and remove the nut.
3. Remove the spring and piston.
4. Loosen all the bolts on the bellows end cap.

CAUTION: This end cap is under slight spring pressure.

5. Break the gasket free and remove the end cap.
6. Note the number of shims next to the cap. These can be reused.

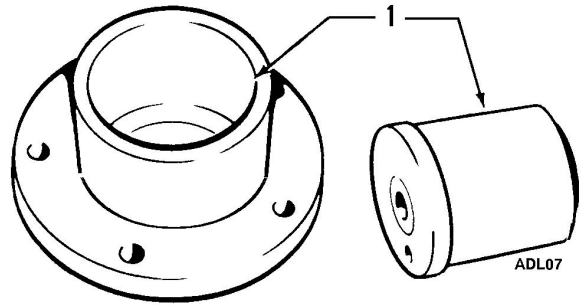


1.	Inspect Cap
2.	Inspect Spring
3.	Shims

Figure 59: Inspect the Parts

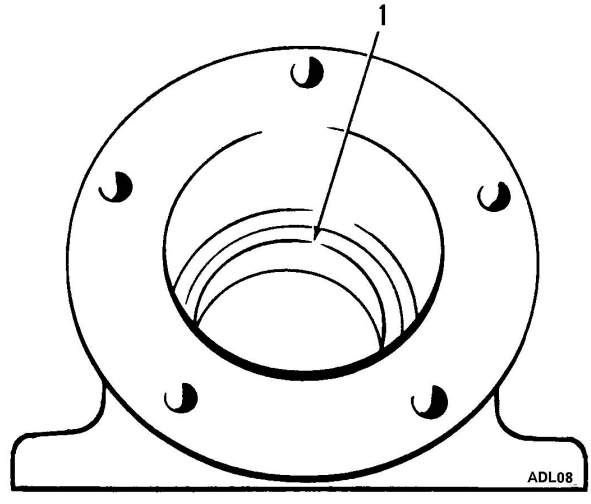
7. Remove the bellows.
8. Inspect all the parts.
   a. Piston and cap for wear (scuff marks).
   b. Body for stripped threads.
   c. Bellows end cap for damage in the pilot hole.

   NOTE: The bellows is normally replaced.



1.	Inspect for Wear

Figure 60: Inspect for Wear



1.	Inspect for Damage

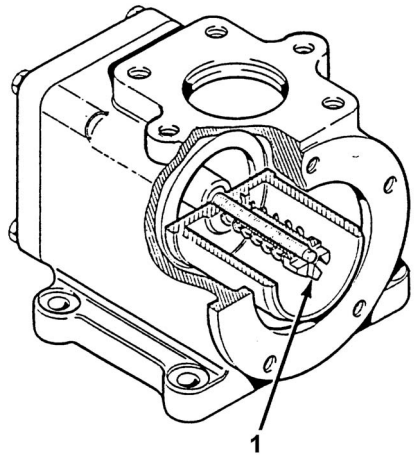
Figure 61: Inspect for Damage

9. Clean the parts that will be reused.

Reassembly

1. Install the bellows with the O-ring in the housing.
2. Center the spring on the bellows shoulder.
3. Oil the gasket, install it on the housing, and place the shims in the end cap (use same number as removed). Tighten the end cap in place with the vent hole closest to the outlet opening of the valve housing.
4. Install the piston, spring and tighten the castle nut until it is firmly seated against the bottom of the piston.

5. Back off the castle nut, one full turn only.
6. Insert the cotter pin.



1.	Tighten castle nut to bottom, then back off 1 turn only. Insert cotter pin

Figure 62: Throttling Valve Reassembly

7. Oil the gasket and install the end cap.
8. The throttling valve will have to be recalibrated on operating unit. (See the Specifications Chapter for the setting.)
9. Adjust by adding or removing shims under the spring.

Installation

1. Install the throttling valve using a new O-ring soaked in compressor oil. Bolt the throttling valve to the compressor.
2. Install the suction valve.
3. Pressurize the compressor and check for leaks. If no leaks are found, evacuate the compressor.
4. Open the refrigeration valves and place the unit in operation.

Liquid Line Solenoid Valves (LLS and LLS2)

NOTE: Valves that have nylon seats must be disassembled before soldering.

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Remove the evaporator access panels.
3. Remove the coil and disassemble the valve.
4. Unsolder the liquid lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damage.

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

CAUTION: Use a heat sink to prevent damage.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Install the evaporator access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Hot Gas Solenoid Valves (HGS and HGS2)

NOTE: Valves that have nylon seats must be disassembled before soldering.

Removal

1. Pump down the low side and equalize the pressure in the high side to slightly positive.
2. Remove the evaporator access panels.
3. Remove the coil and disassemble the valve.
4. Unsolder the hot gas lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damage.

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

CAUTION: Use a heat sink to prevent damage.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Install the evaporator access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Suction Line Solenoid Valves (SLS and SLS2)

NOTE: Valves that have nylon seats must be disassembled before soldering.

Removal

1. Pump down the low side and equalize the pressure in the high side to slightly positive.
2. Remove the evaporator access panels.
3. Remove the coil and disassemble the valve.
4. Unsolder the suction lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damage.

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

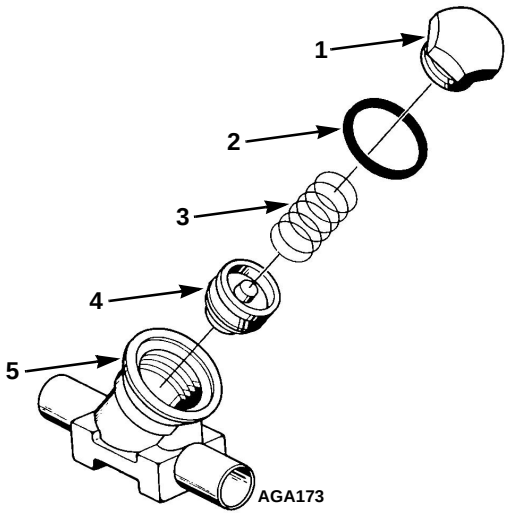
CAUTION: Use a heat sink to prevent damage.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Install the evaporator access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Check Valve Repair (SLCV, SLCV2, SLCV3, LRCV, and PVC)

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Remove the evaporator access panels.
3. Remove the cap nut from the check valve and remove the spring and seat.



1.	Cap
2.	Gasket
3.	Spring
4.	Seat
5.	Body

Figure 63: Check Valve with Cap Nut

Installation

1. Inspect the inside of the check valve body for damage or foreign particles that might adhere to the seat and damage the new seat. If the body is damaged, replace the check valve.
2. Install the new seat and spring. Place a new gasket on the cap and tighten the cap.
3. Pressurize the low side and test for leaks.
4. If no leaks are found, evacuate the system.
5. Install the evaporator access panels.
6. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Check Valve Replacement (SLCV, SLCV2, SLCV3, LRCV, and PVC)

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the evaporator access panels.
3. Unsolder the lines and remove the check valve.

   NOTE: Disassemble the valve before unsoldering.

Installation

1. Clean the tubes for soldering.
2. Place the disassembled check valve in position. The arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Solder the inlet and outlet connections. After the valve cools, reassemble the valve.
4. Pressurize the low side and test for leaks.
5. If no leaks are found, evacuate the system.
6. Install the evaporator access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Condenser Inlet Solenoid Valve (CIS)

Removal

1. Recover the refrigerant charge.
2. Remove the coil and disassemble the valve.
3. Unsolder the hot gas lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink or wrap the valve with wet rags to prevent damaging the valve.

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

CAUTION: Use a heat sink or wrap the valve with wet rags to prevent damaging the valve.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with proper refrigerant and check the compressor oil.

Condenser Inlet Check Valve (CICV) Repair

Removal

1. Recover the refrigerant charge.
2. Remove the cap nut from the check valve, and remove the spring and seat.

Installation

1. Inspect the inside of the check valve body for damage or foreign particles which might adhere to the seat and damage the new seat. If the body is damaged, replace the check valve.
2. Install the new seat and spring. Place the new gasket on cap and torque to 45 ft-lb (61 N•m).
3. Pressurize the refrigeration system and test for leaks.
4. If no leaks are found, evacuate the system.
5. Recharge the unit with proper refrigerant and check the compressor oil.

Condenser Inlet Check Valve (CICV) Replacement

Removal

1. Recover the refrigerant charge.
2. Unsolder the lines and remove the check valve.

   NOTE: Disassemble the valve before unsoldering.

Installation

1. Clean the tubes for soldering.
2. Place the disassembled check valve in position. The arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Solder the inlet and outlet connections. After the valve cools, reassemble it.
4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with proper refrigerant and check the compressor oil.

Receiver Tank Pressure Solenoid Valve (RTPS)

Removal

1. Recover the refrigerant charge.
2. Remove the coil from the valve.
3. Unsolder the hot gas lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink or wrap the valve with wet rags to prevent damage.

Installation

1. Clean the tubes for soldering.
2. Remove the coil from the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, install the coil on the valve.

CAUTION: Use a heat sink or wrap the valve with wet rags to prevent damage.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with proper refrigerant and check the compressor oil.

Purge Valve (PV)

Removal

1. Recover the refrigerant charge.
2. Remove the coil from the valve.
3. Unsolder the refrigeration lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damaging the valve.

Installation

1. Clean the tubes for soldering.
2. Remove the coil from the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the valve and install the coil.

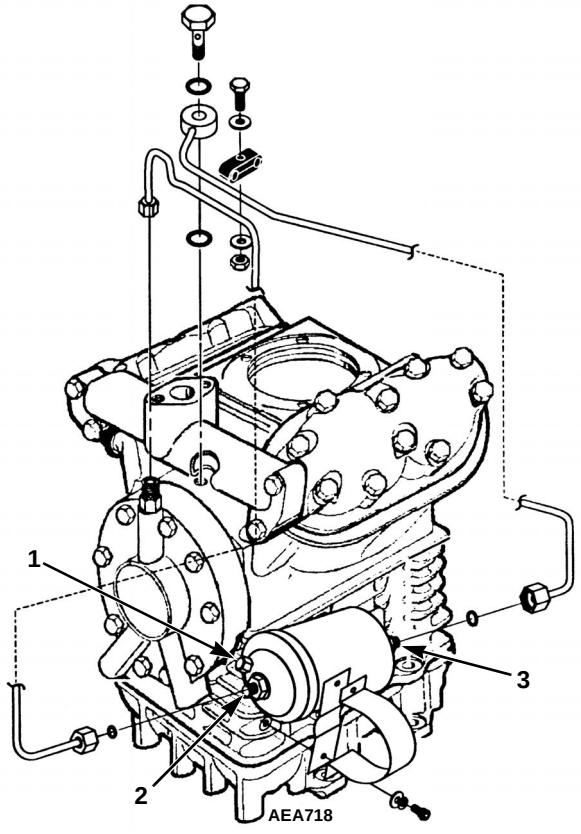
CAUTION: Use a heat sink to prevent damaging the valve.

4. Pressurize the refrigeration system and test for leaks.
5. If no leaks are found, evacuate the system.
6. Recharge the unit with the proper refrigerant.

Compressor Oil Filter

This unit is equipped with a compressor oil filter. The compressor oil filter should be changed when the drier is replaced.

The outlet fitting is larger than the inlet fitting, so the compressor oil filter cannot be put on backwards. There are two fittings on the inlet end of the compressor oil filter. The inlet fitting contains a check valve that prevents reverse flow through the compressor oil filter. The capped fitting is called the oil pressure access port and is used to check the compressor oil pressure (see “Checking Compressor Oil Pressure” on page 95).



1.	Oil Pressure Access Port
2.	Inlet Fitting
3.	Outlet Fitting

Figure 64: Compressor Oil Filter

Use the following procedure to change the compressor oil filter.

1. Pump down the low side and equalize the pressure to slightly positive.
2. Front seat the discharge and suction service valves. Remove the remaining refrigerant from the compressor.
3. Disconnect the oil lines from the compressor oil filter. Hold the oil filter with back-up wrench on the hex behind the ORS fitting.
4. Remove the clamp and the compressor oil filter.
5. Coat the new O-rings with clean compressor oil and place them in the ORS fittings on the ends of the new compressor oil filter.
6. Fasten the new compressor oil filter in place with the clamp.
7. Attach and tighten the oil lines to the compressor oil filter. Hold the oil filter with a back-up wrench on the hex behind the ORS fitting.
8. Evacuate the compressor and filter to a maximum of 500 microns to remove trapped air.
9. Open the service valves, operate the system, and check the compressor oil filter for leaks.

Checking Compressor Oil Pressure

The oil pressure at the oil pressure access port varies with the suction pressure in the compressor. Therefore, we need to calculate the "net oil pressure" to determine the actual compressor oil pressure. The net oil pressure is the pressure at the oil pressure access port minus the suction pressure below the throttling valve. Use the following procedure to check the compressor oil pressure.

1. Attach a suitable oil pressure gauge to the oil pressure access port on the compressor oil filter.
2. Attach the low pressure gauge of a gauge manifold to the fitting on the side of the throttling valve. This fitting allows you to monitor the suction pressure in the compressor below the throttling valve.
3. Start the unit and note the pressure at the oil pressure access port and the suction pressure below the throttling valve.
4. Subtract the suction pressure below the throttling valve from the pressure at the oil pressure access port to get the net oil pressure.

   Pressure at Oil Pressure Access Port
   − Suction Pressure Below Throttling Valve
   = Net Oil Pressure

5. The net oil pressure should be at least 20 psi (138 kPa). If the net oil pressure is low, first check the compressor oil level, then check the compressor oil pump and relief valve.

Priming New Compressor Installations

Thermo King remanufactured compressors have had a special break in process to assure that the oil pump is primed, functioning, and broken in. The following procedure is recommended, but not required for factory-remanufactured compressors.

This procedure must be followed to prevent premature pump failure in any compressor that has had an oil pump installed, especially a compressor that has been stored for any length of time.

1. Attach a suitable oil pressure gauge to the oil pressure access port on the compressor oil filter.
2. Attach the low pressure gauge of a gauge manifold to the fitting on the side of the throttling valve. This fitting allows you to monitor the suction pressure in the compressor below the throttling valve.
3. Disconnect the wires to the fuel solenoid.
4. Disconnect the wires to the high speed solenoid.

   NOTE: The microprocessor will probably record some alarm codes because the solenoids are disconnected and the engine does not start. Clear these alarm codes as necessary.

5. Turn the unit on and let the engine crank (or crank the engine) for 30 seconds, but do not crank the engine for more than 30 seconds.
    a. Note the pressure at the oil pressure access port and the suction pressure below the throttling valve while the engine is cranking. Subtract the suction pressure below the throttling valve from the pressure at the oil pressure access port to get the net oil pressure.
    b. If the compressor does not develop at least 10 psi (96 kPa) of net oil pressure in the first 30 seconds, allow the starter to cool for a few minutes and the crank the engine again for 30 seconds. If 10 psi (96 kPa) of net oil pressure still does not develop, first check the compressor oil level, then check the compressor oil pump and relief valve.
6. As soon as the compressor develops 10 psi (96 kPa) of net oil pressure, re-connected the fuel solenoid wires, but do not re-connect the high speed solenoid wires.
7. Start unit and run the engine on low speed for at least five minutes. If the net oil pressure is above 20 psi (138 kPa) for this period, stop the unit and re-connect the high speed solenoid wires.
8. Run the engine on high speed for at least five more minutes. The compressor oil pump is now primed and broken in.

Unit and Engine Mounting Bolts

Check and tighten all unit and engine mounting bolts during scheduled maintenance inspections. Torque the unit mounting bolts to 60 ft-lb (81 N•m). Torque the engine mounting bolts to 150 ft-lb (203 N•m).

Unit Inspection

Inspect the unit during pretrip inspection and scheduled maintenance inspections for loose or broken wires or hardware, compressor oil leaks, or other physical damage which might affect unit performance and require repair or replacement of parts.

Condenser, Evaporator, and Radiator Coils

Clean the coils during scheduled maintenance inspections. Remove any debris (e.g., leaves or plastic wrap) that reduces the air flow. Clean dirty coils with compressed air or a pressure washer. Be careful not to bend the fins when cleaning a coil. If possible, blow the air or water through the coil in the direction opposite the normal airflow. Repair bent fins and any other noticeable damage.

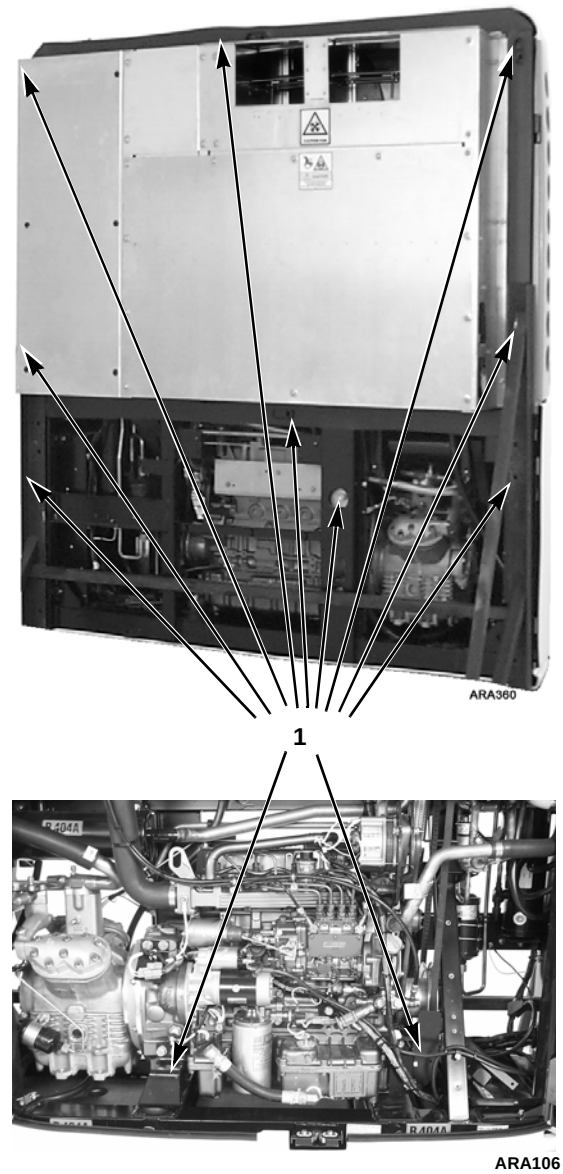
Defrost Drains

Clean the defrost drains during scheduled maintenance inspections to be sure the lines remain open.

Unit Installation

All nuts that hold the unit to the trailer are accessible using an impact wrench with a 10 in. extension, ball-type swivel and a deep-well socket.

NOTE: The nuts for mounting the unit should be elastic stop nuts (Nylock type).



1.	Check Bolts for Tightness

Figure 65: Unit and Engine Mounting Bolts

DE Defrost Dampers

Check the dampers during scheduled maintenance inspections for shaft wear, end play, and sealing against air flow.

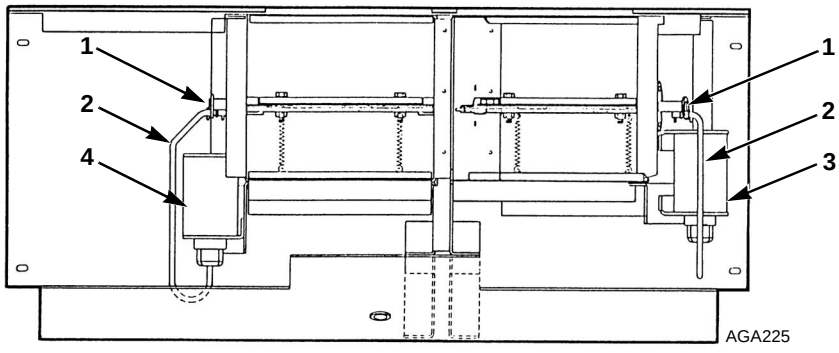
Position the damper so that air flow is stopped on the top and bottom with the solenoid plunger bottomed.

To adjust the damper:

1. Remove the damper assembly from the evaporator.
2. Disconnect the solenoid rod from the damper shaft.
3. Energize the solenoid (apply 12 volts to the 29A or 29-2 circuit) and check “Distance A”, the distance from the upper mounting hole to the end of the solenoid rod when the solenoid is energized.

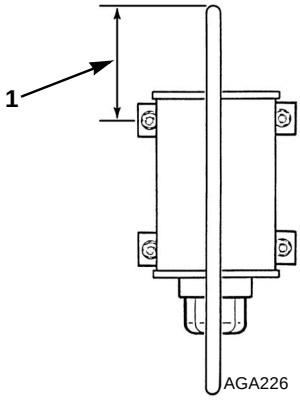
   Control Box Side—Distance A = 3.36 in. (85.3 mm)

   Compressor Side—Distance A = 2.09 in. (53.1 mm)



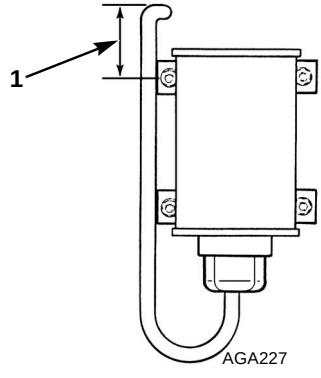
1.	Damper Shaft	3.	Control Box Side Damper Solenoid
2.	Solenoid Rod	4.	Compressor Side Damper Solenoid

Figure 66: Rear View of DE Damper Assembly



1.	Distance A = 85.3 mm (3.36 in.)

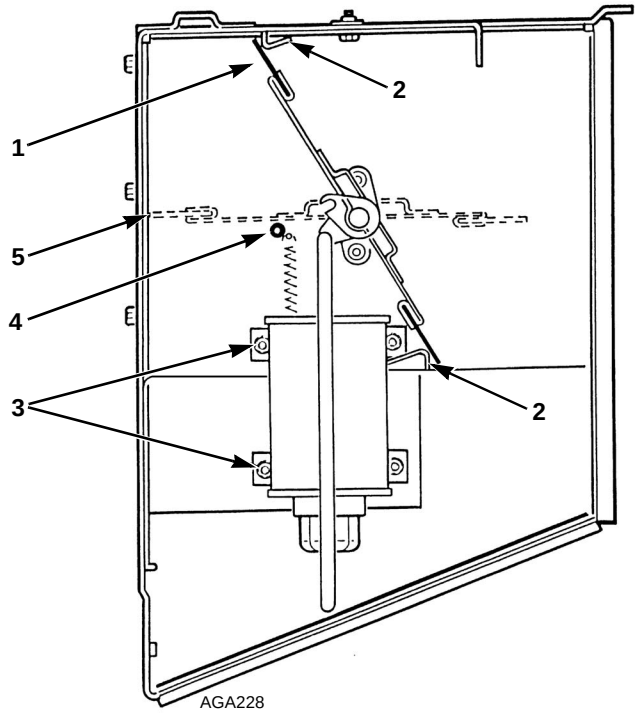
Figure 67: Compressor Side Damper Solenoid



1.	Distance A = 53.1 mm (2.09 in.)

Figure 68: Control Box Side Damper Solenoid

1. If necessary, adjust Distance A to the proper dimension by loosening the locknut on the end of the solenoid plunger and turning the plunger to move the solenoid rod. Tighten the locknut when Distance A is correct.
2. De-energize the solenoid and connect the solenoid rod to the damper shaft.
3. Energize the solenoid and check the damper blade to make sure that both edges contact the damper housing. If necessary, adjust this by loosening the solenoid mounting bolts and moving the solenoid. Tighten the solenoid mounting bolts when both damper blades contact the damper housing.
4. Adjust the damper blade stops so they contact the edges of the damper blade. This keeps the damper from sticking closed.
5. De-energize and energize the damper several times to make sure that the damper operates correctly and seals properly.
6. Make sure that the damper blade rests on the round stops when the damper is open. Adjust the round stops if necessary.
7. Install the damper assembly in the evaporator.



1.	Closed Position	4.	Round Stop
2.	Stop	5.	Open Position
3.	Mounting Bolts		

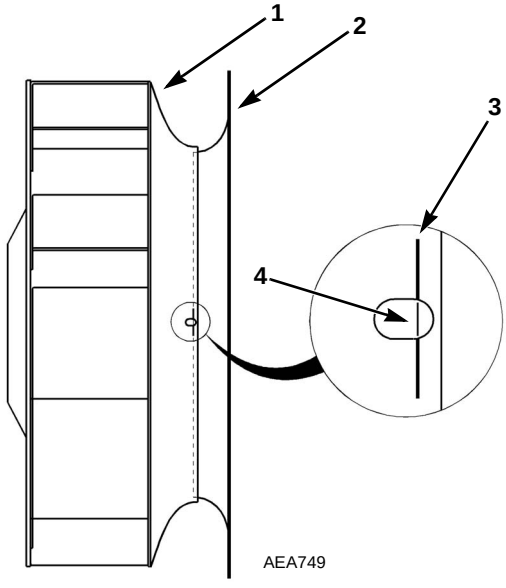
Figure 69: Damper Adjustment (Control Box Side Shown Compressor Side Similar)

Condenser and Evaporator Fan Location

When mounting the condenser or evaporator fan and hub assembly on the fanshaft, the blowers and inlet orifices must be properly aligned for proper air flow and to prevent damage to the blower.

Condenser Fan Blower Alignment

1. Loosen the condenser inlet ring (spinning) on the condenser coil bulkhead.
2. Slide the blower towards the inlet ring until it contacts the inlet ring. This centers the inlet ring in the blower orifice.
3. Tighten the inlet ring securely.
4. Slide the blower away from the inlet ring.



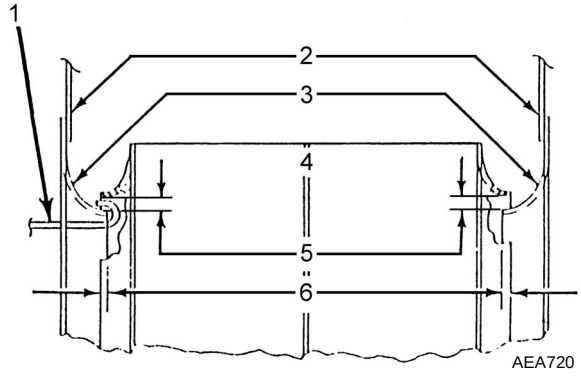
1.	Blower Wheel	3.	Alignment Mark
2.	Inlet Ring	4.	Edge of Inlet Ring

Figure 70: Condenser Blower Alignment

5. Pass a gauge wire completely around the blower orifice to check for uniform clearance.
6. Spin the blower by hand to check for blower distortion.
7. Position the blower so the edge of the inlet ring lines up with the alignment mark on the blower.
8. Torque blower hub bolts to 18 ft-lb (24 N•m).

Evaporator Fan Blower Alignment

1. Loosen the inlet rings on the sides of the blower housing.
2. Center the blower wheel in the blower housing with equal overlap on both inlet rings. The overlap on each ring should be approximately 0.15 in. (3.8 mm).
3. Tighten the hub bolts that hold the blower wheel on the fanshaft. Torque the blower hub bolts to 18 ft-lb (24 N•m).
4. Center the inlet rings in the blower orifices. Tighten the inlet rings securely.
5. Check the radial clearance by passing a wire completely around the circumference of the inlet rings and the blower wheel.
6. Position the seal housing on the inner panel so the seal is centered on the spacer and the spacer spins freely in the seal.



1.	Check Clearance with a Wire
2.	Blower Housing Sides
3.	Inlet Rings
4.	Evaporator Blower
5.	Radial Clearance
6.	Equalize Blower Inlet Overlap

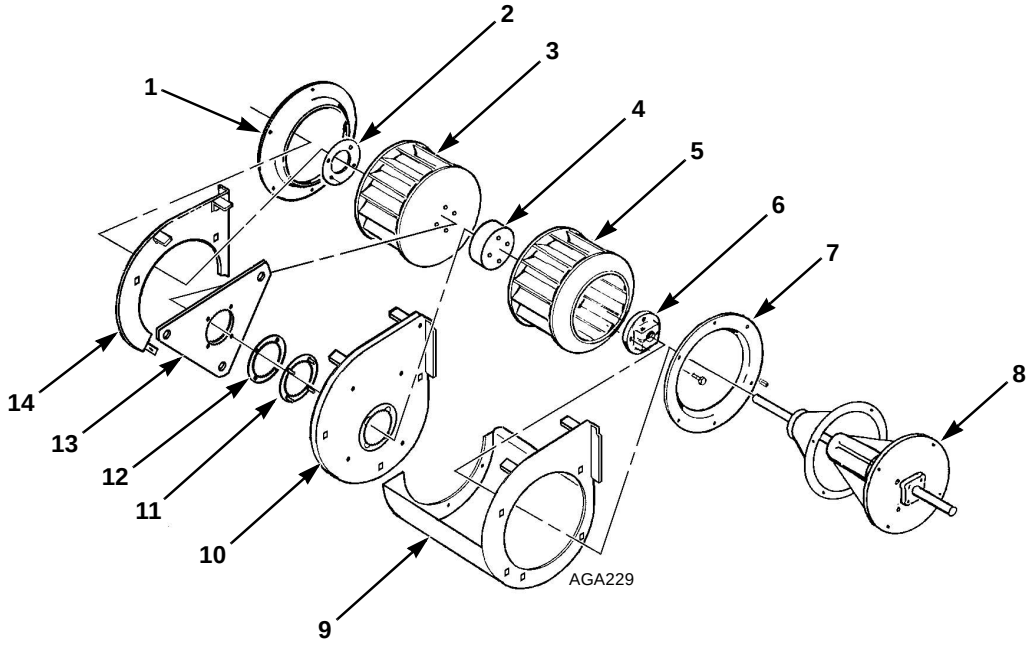
Figure 71: Evaporator Fan Location

DE Evaporator Fan Blower Removal and Installation

Removal

NOTE: The blower assembly is balanced and permanent index marks are placed on the components. Pay attention to these index marks when disassembling the blower. This will make it easier to correctly reassemble the blower.

1. Remove the curbside panel and inlet ring.
2. Remove two of the 5/16-18 x 3.0 in. bolts from the blower ring and replace them with two 5/16-18 x 4.0 in. studs. The studs keep the blower components aligned.
3. Remove the other two 5/16-18 x 3.0 in. bolts form the blower ring.
4. Remove the blower ring, the curbside blower, and the spacer.
5. Remove the seal housing and the seal with the inner panel.
6. Remove the roadside blower.
7. Remove the hub from the fanshaft.
8. If necessary, remove the blower housing and the roadside inlet ring.



1.	Compressor Side Inlet Ring	8.	Fan Shaft Assembly
2.	Blower Ring	9.	Blower Housing
3.	Compressor Side Blower	10.	Inner Panel
4.	Spacer	11.	Seal Ring
5.	Control Box Side Blower	12.	Seal
6.	Hub	13.	Seal Housing
7.	Control Box Side Inlet Ring	14.	Compressor Side Panel

Figure 72: DE Evaporator Blower Components

Installation

NOTE: The blower assembly is balanced and permanent index marks are placed on the components. Make sure to align these index marks when assembling the blower. This keeps the blower balanced.

1. If necessary install the blower housing and the roadside inlet ring.
2. Place two 5/16-18 x 4.0 in. studs in the hub. These studs are used temporarily to keep the blower components aligned.
3. Place the hub on the fanshaft.
4. Place the roadside blower on the hub.
5. Place the spacer on the hub.
6. Lubricate the spacer and seal with grease P/N 204-475.
7. Install the inner panel.
8. Install the seal housing and seal.
9. Place the curbside blower on the hub.
10. Place the blower ring on the hub. Make sure that the index marks on the components of blower assembly are all correctly aligned.
11. Insert two 5/16-18 x 3.0 in. bolts into the blower ring and blower assembly and thread the bolts into the hub.
12. Remove the two 5/16-18 x 4.0 in. studs from the hub and replace them with two 5/16-18 x 3.0 in. bolts.
13. Torque the four 5/16-18 x 3.0 in. bolts to 13 to 15 ft-lb (18 to 20 N•m).
14. Install the curbside panel and inlet ring.
15. Align the evaporator blower. See “Evaporator Fan Blower Alignment” on page 100.

Fan Shaft Assembly

The unit is equipped with a one-piece fan shaft assembly that contains tapered roller bearings in a sealed oil reservoir.

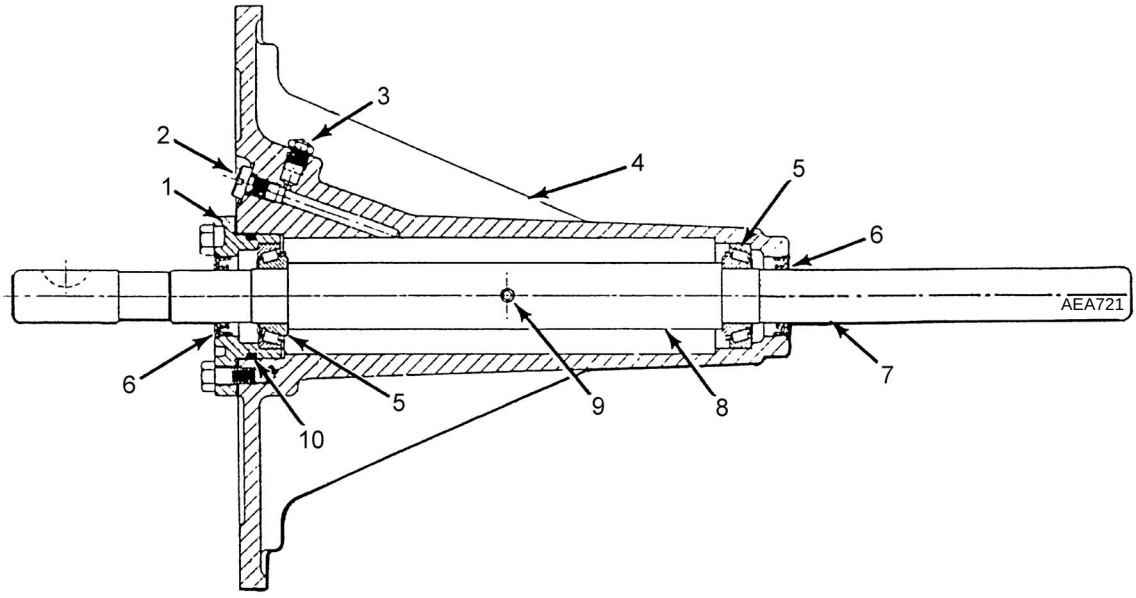
This assembly does not require any maintenance. There is a level plug and a fill plug, but they are not normally used except after removal and repair of the fan shaft assembly. The condenser and evaporator end oil seals should be checked during the pre-trip inspection for oil leakage. If there is any sign of leakage, the fan shaft assembly should be removed and repaired.

NOTE: The fan shaft assembly requires a special lubricant, Thermo King P/N 203-278.

Fan Shaft Assembly Overhaul

Disassembly

1. Remove the fan shaft assembly from the unit. Remove both oil plugs and drain the oil from the housing.
2. After draining the oil from the housing, remove the four retaining bolts from the condenser end of the assembly.
3. To remove the shaft from the assembly, tap the opposite end of the shaft with a soft hammer. After the shaft has been removed, clean all parts in clean solvent.
4. Using a punch, remove the oil seal from the evaporator end of the assembly. With the seal removed, clean the housing in clean solvent.
5. Check the condition of the vent. If it is loose or damaged, it must be repaired or replaced.
6. After all the parts are cleaned, inspect the bearings and bearing races for wear or damage.
7. If necessary, remove the bearings by tapping them off the shaft with a hammer and a punch. Be careful not to damage the shaft with the punch.
8. The bearing races can now be driven out with a punch and replaced in the same manner.



1.	Cap and Shims	6.	Oil Seal
2.	Oil Plug Screw (Use Oil P/N 203-278)	7.	Shaft
3.	Breather Vent	8.	Sleeve
4.	Housing	9.	Pin
5.	Roller Bearing	10.	O-ring

Figure 73: Fan Shaft Assembly

Reassembly

1. Tap the new bearings on the shaft with a pipe.
2. Install new oil seals after replacing the bearing races.
3. Replace the shaft in the housing. Install a new seal in the retainer cap. Use the original shims and replace the O-ring if needed.
4. Install the retainer cap assembly over the shaft, then install the bolts.
5. Torque the bolts in a criss-cross pattern in equal steps to 80 in-lb (9.04 N•m).
6. Lock the assembly in a vise and set up a dial indicator to read end-play. To measure the end-play, rotate the shaft while pushing in one direction and set the dial indicator to ‘0’. Now rotate the shaft and pull in the opposite direction while reading the dial indicator. End-play should be 0.001 to 0.005 in. (0.025 to 0.127 mm). If end-play is incorrect, use different shims to obtain correct end-play.

Shims available from the Service Parts Department	
0.020 in. (0.500 mm)	Thermo King P/N 99-4231
0.007 in. (0.177 mm)	Thermo King P/N 99-2902
0.005 in. (0.127 mm)	Thermo King P/N 99-2901

7. After correct end-play is obtained, add oil for the bearings.
8. Lock the assembly in a vise with the vent facing up. Pour the oil (P/N 203-278) through the top plug until it runs out of the side hole. The assembly holds 2.5 oz (74 ml). Check the condition of the O-ring used on the plugs and replace if necessary. Install the top and side plugs. Clean up any spillage.
9. Place the assembly on the workbench with the vent up. Rotate the shaft by hand. The shaft should be free enough to rotate without having to hold the housing.

CAUTION: When installing the fan shaft assembly, make sure that the vent is mounted facing up.

Idler Assembly

The unit is equipped with a one-piece idler assembly that contains tapered roller bearings in a sealed oil reservoir. This assembly does not require any maintenance. There is a level plug and a fill plug, but they are not normally used except after removal and repair of the idler assembly. The roadside end oil seal and the curbside end oil seal should be checked during the pre-trip inspection for oil leakage. If there is any sign of leakage, the idler assembly should be removed and repaired.

Idler Assembly Overhaul

Disassembly

1. Remove the idler assembly from the unit. Remove both oil plugs and drain the oil from the housing.
2. After draining the oil from the housing, remove the four retaining bolts from the curbside end of the assembly.
3. To remove the shaft from the assembly, tap the opposite end of the shaft with a soft hammer. After the shaft has been removed, clean all the parts in clean solvent.
4. Using a punch, remove the oil seal from the curbside end of the assembly. With the seal removed, clean the housing in solvent.
5. Check the condition of the vent. If it is loose or damaged, it must be repaired or replaced.
6. After all the parts are cleaned, inspect the bearings and bearing races for wear or damage.
7. To replace the bearings, first drive bearing off shaft with a punch at notch in the base of the shaft.

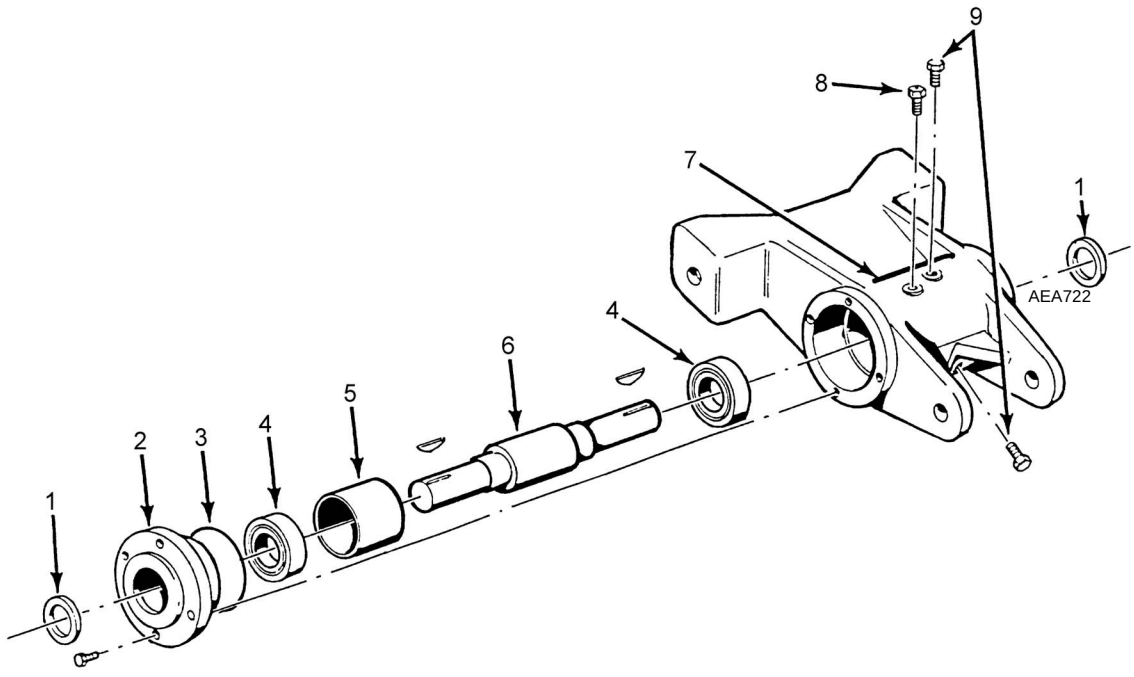
Reassembly

1. Install the new bearings on the shaft with a pipe. Place the pipe over the shaft and drive bearing down. Turn the shaft upside down, and use the pipe to drive the other bearing down.
2. Install a new oil seal on the curbside end of the assembly after replacing the bearing race and splash guard.
3. Replace the shaft in the housing. Install a new seal in the retainer cap. Use the original shims and replace the O-ring if needed.
4. Install the retainer cap assembly over the shaft, then install the bolts.
5. Torque the bolts in a criss-cross pattern in equal steps to 80 in-lb (9.04 N•m).
6. Lock the assembly in a vise and set up a dial indicator to read end-play. To measure the end-play, rotate the shaft while pushing in one direction, and set the dial indicator to ‘0’. Now rotate the shaft and pull in the opposite direction while reading the dial indicator. End-play should be 0.001 to 0.005 in. (0.025 to 0.127 mm). If end-play is incorrect, use different shims to obtain correct end-play.

Shims available from the Service Parts Department	
0.020 in. (0.500 mm)	Thermo King P/N 99-4231
0.007 in. (0.177 mm)	Thermo King P/N 99-2902
0.005 in. (0.127 mm)	Thermo King P/N 99-2901

7. After the correct end-play is obtained, add approximately 1.5 oz (44 ml) of oil for the bearings.
8. Lock the assembly in a vise with the vent facing up. Pour the oil through the top plug until it runs out of the side hole. Check the condition of the O-ring used on the plugs and replace if necessary. Install the top and side plugs. Clean up any spillage.
9. Place the assembly on the workbench with the vent up. Rotate the shaft by hand. The shaft should be free enough to rotate without having to hold the housing.

CAUTION: Reinstall the assembly into the unit, making sure the vent is mounted facing up.



1.	Oil Seal	6.	Shaft
2.	Cap and Shims	7.	Housing
3.	O-ring	8.	Breather Vent
4.	Roller Bearing	9.	Oil Plug Screw (Use Oil P/N 203-278)
5.	Splash Guard Tube		

Figure 74: Idler Assembly

Mechanical Diagnosis

Condition	Possible Cause	Remedy
Engine will not crank	Electrical problem	Check and repair electrical system
	Defective starter solenoid	Replace solenoid
	Defective starter	Repair starter
	Water in cylinders	Check for hydrostatic lock. Remove injectors and turn engine slowly
Starter motor turns but engine does not crank	Starter clutch defective	Replace
Engine cranks but fails to start	Fuel solenoid not energized	Check 8D and 8DP circuits and fuel solenoid relay. Check that YAN = YES in Super Guarded Access. Refer to appropriate Microprocessor Diagnostic Manual.
	Fuel solenoid defective or stuck	Replace
	Fuel injection pump defective	Replace pump
	Air heater defective	Replace
	No fuel or wrong fuel	Fill with proper fuel
	Fuel pump defective	Replace pump
	Air in fuel system	Bleed air
	Compression low	Overhaul engine
	Injection nozzles defective	Replace nozzles
	Incorrect timing	Adjust timing
	Air cleaner clogged	Replace air filter
	Exhaust plugged	Clean exhaust
	Defective HPCO	Replace HPCO
Engine stops after starting	Air in injection pump	Bleed fuel system
	Fuel filter obstructed	Replace filter element
	High head pressure	Eliminate cause of high head pressure
	Vent of fuel tank obstructed	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines
Engine does not develop full power	Air intake system clogged	Clean air intake system
	Fuel tank vent clogged	Unclog vent
	Clogged fuel tank or fuel lines	Clean fuel tank and fuel lines
	Speed adjustment wrong	Adjust speed
	Insufficient fuel volume leaving filter	Check for dirty filter or air in system
	Air cleaner clogged	Replace air filter
	Delivery of fuel pump insufficient	Repair pump
	Injection pump timing off	Adjusting timing
	Injection nozzles defective	Repair or replace nozzles
	Compression low or unbalanced	Overhaul engine
	Worn injection pump plungers, delivery valve defective, injection rate too low, gum formations	Repair or replace pump

Condition	Possible Cause	Remedy
Engine speed too high	Misadjusted high speed solenoid	Adjust high speed solenoid
	Defective injection pump	Repair injection pump
Engine fails to stop when unit is Off	Fuel solenoid defective	Replace
	Injection pump defective	Replace pump
Engine knocks heavily	Air in system	Bleed fuel system
	Injection pump not timed	Retime injection pump
	Wrong fuel	Change fuel
	Compression too low	Overhaul engine
	Injection nozzles fouled or opening pressure too low	Clean, repair or replace injection nozzles
	Delivery valve spring broken	Replace spring or repair injection pump
	Valve out of adjustment	Adjust valves
	Fuel return line plugged	Remove return line restriction
	Rod or main bearing worn	Replace rod or main bearings
Engine runs hot	Dirty radiator	Wash radiator
	Coolant level is low	Add coolant
	Cooling system heavily scaled	Cleaning cooling system
	Cylinder head gasket leaks	Replace cylinder head gasket. Use correct gasket
	Faulty thermostat	Check or replace thermostat
	Loose or worn water pump belt	Replace belt
Oil pressure low	Insufficient oil in pan	Add oil
	Faulty oil pressure switch	Check oil pressure switch. Replace if necessary
	Oil control valve defective	Check oil pressure control valve
	Worn oil pump, camshaft, main or connecting rod bearings, loose oil gallery plug	Repair engine
High oil consumption	Oil leakage	Check and eliminate possible causes at rocker arm cover, oil lines, oil filter, front timing cover or crankshaft seals
	Damaged valve seals	Replace seals on valve stem
	Worn valve stem	Replace valves
	Broken piston rings or cylinder bore worn or scored	Have engine repaired and rebored. Replace broken piston rings
	Clogged air cleaner system	Unclog air cleaner

Engine Emits Excessive Smoke

White Smoke

Fuel is not burning

- Air or water in fuel
- Incorrect timing
- Poor compression
- Faulty injectors

Black Smoke

Excessive Fuel to Air Ratio

- Type of fuel used
- Cold engine
- Excessive load
- Clogged air intake system
- Faulty nozzles
- Poor compression
- Restricted exhaust
- Faulty injection pump

Blue Smoke

Oil Consumption

- Poor compression
- Defective valve seals

Refrigeration Diagnosis

Rapid cycling between Cool and Heat	Unit cools in Heat and Defrost cycle	Unit heats in Refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	Symptom / Possible Causes
			•			•									•	•		Overcharge of refrigerant
				•			•		•	•						•	•	Shortage of refrigerant
				•				•	•							•	•	No refrigerant
			•															Air through condenser too hot (ambient)
			•															Air flow through condenser restricted
				•			•			•								Air through condenser too cold (ambient)
			•												•	•		Air in refrigerant system
			•															Condenser fan blades bent or broken
•																		Air short cycling around evaporator coil
							•											Air through evaporator restricted
							•		•		•				•			Evaporator needs defrosting
				•									•					Compressor discharge valves leaking
						•						•						Compressor suction valves leaking
																•		Too much compressor oil in system
															•			Faulty oil pump in compressor
															•			Faulty compressor drive coupling
															•			Compressor bearing loose or burned out
				•								•	•	•	•			Broken valve plate in compressor
							•									•		Expansion valve power element lost its charge
						•					•							Expansion valve feeler bulb improperly mounted
						•					•					•		Expansion valve feeler bulb making poor contact
						•					•							Expansion valve open too much
							•									•		Expansion valve closed too much
						•					•							Expansion valve needle eroded or leaking
							•		•							•		Expansion valve partially closed by ice, dirt or wax
						•					•				•			Liquid refrigerant entering compressor
							•		•									Restricted line on the low side
			•				•		•							•		Restricted line on the high side
			•				•		•							•		Restricted drier
																	•	Damper open
							•		•							•		Damper stuck closed
					•													Discharge service valve back seated

Rapid cycling between Cool and Heat	Unit cools in Heat and Defrost cycle	Unit heats in Refrigeration cycle	High head pressure	Low head pressure	No head pressure	High suction pressure	Low suction pressure	No suction pressure	Unit operating in a vacuum	Receiver sight glass empty	Suction line frosting back	Unable to pump down system	Unable to pull vacuum in low side	Unable to hold vacuum in low side	Noisy compressor	Unit not refrigerating	Unit not heating or defrosting	Symptom / Possible Causes
								•										Suction service valve back seated
	•	•		•		•						•				•	•	Faulty CIS
	•	•										•				•	•	Faulty HGS
	•																•	Loose or broken electrical connections
•						•	•		•							•		Sensor out of calibration
						•	•	•	•									Compound pressure gauge out of calibration
												•						Leaky receiver tank outlet valve
						•	•					•				•	•	Leaky check valve
						•	•									•	•	Faulty check valve
			•															Leaky receiver tank pressure solenoid (RTPS)
				•													•	Closed receiver tank pressure solenoid (RTPS)
		•				•										•	•	Leaky hot gas solenoid (HGS)
			•														•	Closed hot gas solenoid (HGS)
						•										•	•	Leaky liquid line solenoid (LLS)
			•				•	•	•							•	•	Closed liquid line solenoid (LLS)
																	•	Leaky liquid return check vale (LRCV)
						•										•		Leaky suction line solenoid (SLS)
						•										•	•	Leaky suction line check valve (SLCV)
						•										•		Leaky Zone 2 or 3 hot gas solenoid (HGS2 or 3)
			•				•									•	•	Closed Zone 2 or 3 hot gas solenoid (HGS2 or 3)
																•	•	Leaky Zone 2 or 3 liquid line solenoid (LLS2 or 3)
							•									•	•	Closed Zone 2 or 3 liquid line solenoid (LLS2 or 3)
																	•	Leaky Zone 2 or 3 liquid return check valve (LRCV2 or 3)
						•										•		Leaky Zone 2 or 3 suction line solenoid (SLS2 or 3)
						•										•	•	Leaky Zone 2 or 3 suction line check valve (SLCV2 or 3)
						•							•	•		•		Leaky purge valve (PV)

Remote Evaporator Specifications

Refrigeration System

Evaporator Coil Type	Direct Expansion
Refrigerant Type	R-404A
Heat/Defrost Method	Hot Gas

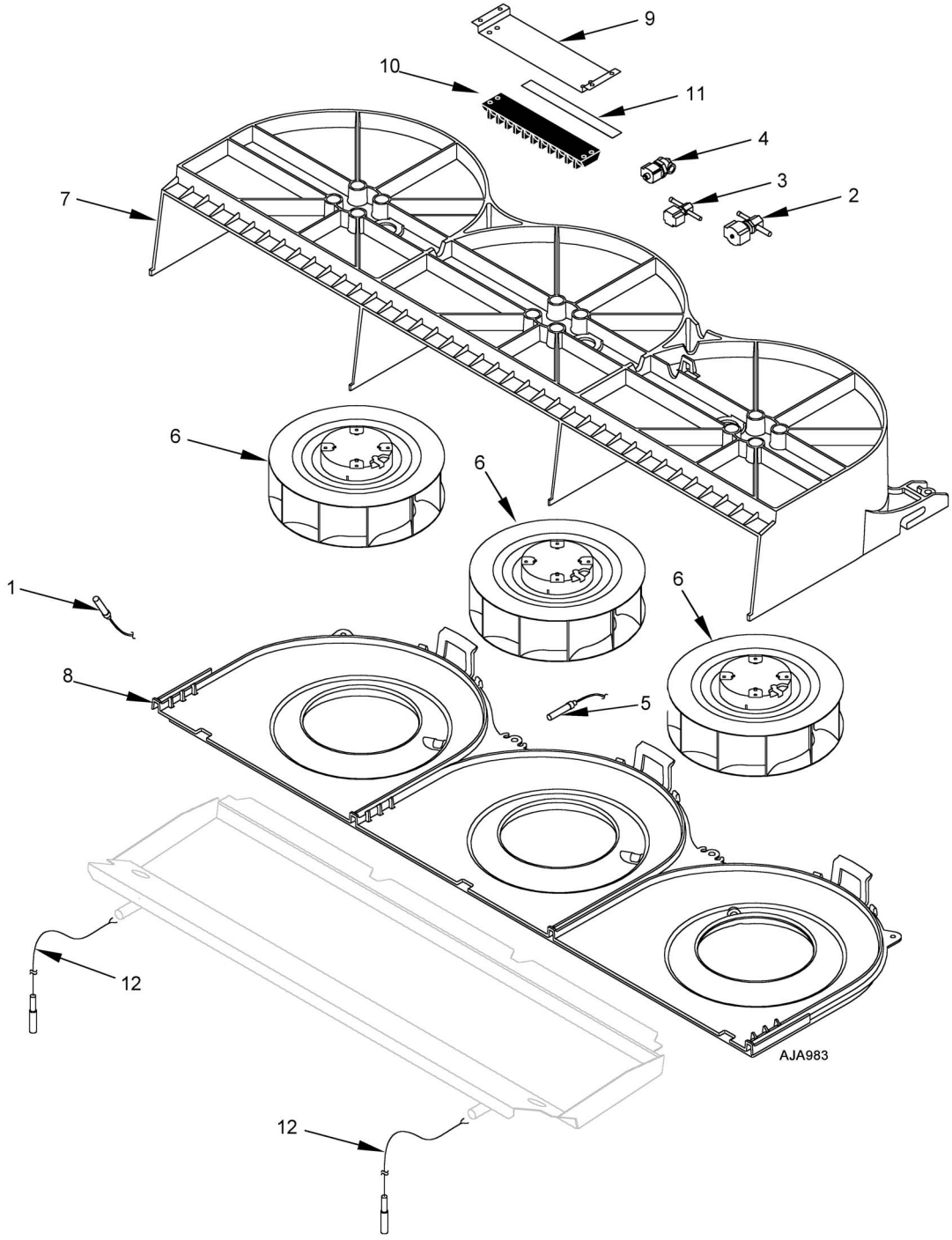
Electrical

Control System Voltage	12.5 Vdc
Circuit Breaker CB1—Zone 3 Fan Motors	30 amp, auto reset
Fuse F12—Zone 3 Fan Motors	25 amp
Fuse F13—Zone 3 Solenoids	15 amp
Fan Motors (each):	
Power Rating	0.13 hp (100 Watts)
rpm	2390
Full Load Amps	7 amps (per motor)
Remote Liquid Line Solenoid:	
Current Draw	1.3 amps
Resistance	9.6 ohms
Remote Hot Gas Solenoid:	
Current Draw	1.5 amps
Resistance	8.3 ohms
Remote Suction Line Solenoid:	
Current Draw	1.5 amps
Resistance	8.3 ohms

Remote Evaporator Maintenance Inspection Schedule

Pretrip	Every 1,500 Hours	Every 3,000 Hours*	Annual/ 4,500 Hours	Inspect/Service These Items
				Electrical
	•	•	•	Inspect wire harness for damaged wires or connections.
	•	•	•	Inspect/replace DC fan motors.
				Structural
•	•	•	•	Visually inspect unit for fluid leaks.
•	•	•	•	Visually inspect unit for damaged, loose, or broken parts.
	•	•	•	Clean entire unit including evaporator coils and defrost drains.
			•	Check all unit mounting bolts, brackets, lines, hoses, etc.

Remote Evaporator Unit Description



1.	Coil Temperature Sensor (Ungraded)	5.	Return Air Sensor (Graded)	9.	Terminal Board Bracket
2.	Hot Gas Solenoid	6.	Variable Blower (12 V)	10.	Terminal Board
3.	Liquid Solenoid	7.	Blower Housing	11.	Terminal Board Markstrip
4.	Suction Line Solenoid	8.	Blower Cover	12.	Resistance Wire

Figure 75: Spectrum S-3 Evaporator Components

Figure 76: Spectrum S-3 Evaporator - Front View

Figure 77: Spectrum S-3 Evaporator - Back View

The Spectrum DE multi-temperature refrigeration system provides heavy duty temperature control for multiple compartment trailers. The system provides direct expansion cooling in all trailer compartments. Non-contaminating refrigerant tap-ins in the host unit evaporator provide convenient refrigerant piping connections for the remote evaporator.

The host unit mounts on the front of the trailer with the evaporator protruding into the trailer. The remote evaporator is a ceiling mounted Spectrum unit.

Heat and defrost is provided in all compartments by circulating hot refrigerant gas through the evaporators.

Controls for the remote evaporator are located on the host unit (and in the optional remote control box if so equipped).

Unit Operation

The remote evaporator cycles between cool, null and heat to maintain the trailer's compartment at the setpoint. The operating modes include Cool, Null, Heat, and Defrost.

Power to run the direct current fan motors is supplied by the alternator in the host unit.

When cooling is required, the Smart Reefer Multi-Temp µP-IV microprocessor energizes the remote liquid line solenoid valve. Refrigerant flows through the evaporator coil to provide cooling.

When the compartment temperature is near setpoint, the Smart Reefer Multi-Temp µP-IV microprocessor de-energizes the remote liquid line solenoid valve and switches the remote evaporator to null.

The Smart Reefer Multi-Temp µP-IV microprocessor energizes the remote hot gas solenoid when the remote compartment requires heat or defrost.

Defrost

The Defrost mode can be initiated any time the evaporator coil temperature is below 45 F (7 C). Defrost is initiated automatically by the controller or manually by selecting defrost from the Defrost Prompt Screen for the desired zone.

The evaporator fan stops during defrost. The Defrost mode will continue until the evaporator coil temperature rises to 58 F (14 C), causing the controller to terminate defrost. After defrost, the evaporator may shift back to Cool, Null or Heat.

Operating Modes

Remote evaporator operating modes are:

- Cool
- Null
- Heat
- Defrost

NOTE: The controller locks out heat at setpoints below 15 F (-9.5 C).

Unit Features

- Direct Expansion Evaporator Coil
- Smart Reefer Multi-Temp µP-IV Microprocessor
- 12 Vdc Fan Motor
- Aluminum Housing
- Liquid Line Solenoid
- Hot Gas Solenoid
- Suction Line Solenoid
- Liquid Return Check Valve

Unit Protection Devices

- Circuit Breaker in Host Unit (located inside the control box)
- Fuses in Host Unit (located on the relay board)

Serial Number Location

Unit: Nameplate on the right end of the unit frame.

AJA985

1.	Nameplate on Right End of Unit Frame

Figure 78: Serial Number Location

Remote Evaporator Electrical Maintenance

Smart Reefer Multi-Temp µP-IV Microprocessor Controlled Components

Refer to the appropriate Microprocessor Diagnosis Manual for information about maintenance of the microprocessor controlled components.

Unit Wiring

Inspect the unit wiring and wire harnesses during scheduled maintenance inspections for loose, chaffed or broken wires to protect against unit malfunction due to opens or shorts.

Remote Evaporator Refrigeration Service Operations

NOTE: It is generally good practice to replace the filter drier whenever the high side is opened or when the low side is opened for an extended period of time.

Expansion Valve Assembly

Removal

1. Pump down the low side and equalize the pressure to slightly positive. Remove the evaporator access panels.
2. Disconnect the liquid inlet line and distributor from the expansion valve.
3. Remove the feeler bulb from the clamp. Note the position of the feeler bulb on the suction line.
4. Disconnect the equalizer line.
5. Remove the expansion valve assembly from the unit.

Installation

1. Place the expansion valve in the unit.
2. Connect the equalizer line to the expansion valve.
3. Connect the liquid inlet line and distributor to the expansion valve.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and feeler bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or the operation will be faulty. Wrap it with insulating tape.
5. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
6. Install the access panels.
7. Open the refrigeration valves and place the unit in operation.
8. Test the unit to see that the expansion valve is properly installed.

Evaporator Coil

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Disconnect the distributor from the expansion valve.
3. Remove the insulating tape and feeler bulb from the suction line. Note the position of the feeler bulb on the suction line. Disconnect the equalizer line from the suction line.
4. Heat and unsolder the suction line connection to the evaporator coil.
5. Remove the mounting bolts and slide the coil from the housing.

Installation

1. Place the evaporator coil in the evaporator housing and install the mounting bolts.
2. Clean and solder the suction line connections to the evaporator coil.
3. Connect the distributor to the expansion valve.
4. Clean the suction line to a bright polished condition. Install the feeler bulb clamps and the feeler bulb on the suction line. Locate the bulb on the side of the suction line in its former position. The feeler bulb must make good contact with the suction line or the operation will be faulty. Wrap it with insulating tape.
5. Connect the equalizer line to the suction line.
6. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side.
7. Install the access panels.
8. Open the refrigeration valves and place the unit in operation. Check the refrigerant charge and compressor oil. Add as required.

Solenoid Valves

NOTE: Valves that have nylon seats must be disassembled before soldering.

Removal

1. Pump down the low side and equalize the pressure to slightly positive. For the hot gas valve, recover the refrigerant charge.
2. Remove the access panels.
3. Remove the coil and disassemble the valve.
4. Unsolder the refrigeration lines from the valve, and remove the valve from the unit.

CAUTION: Use a heat sink to prevent damaging the valve.

Installation

1. Clean the tubes for soldering.
2. Remove the coil, disassemble the valve, and place the valve in position.
3. Solder the inlet and outlet connections. After the valve cools, assemble the vale and install the coil.

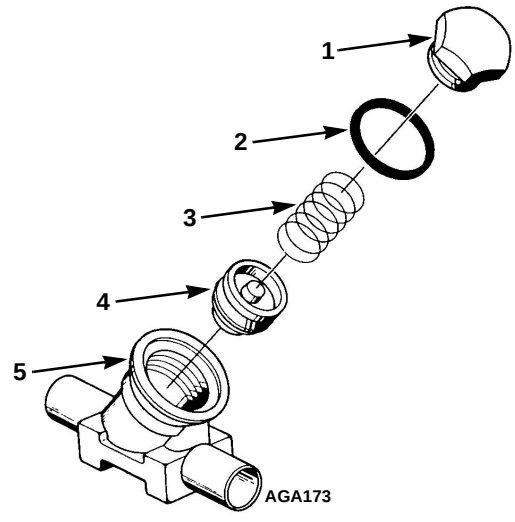
CAUTION: Use a heat sink to prevent damaging the valve.

4. Pressurize the low side and test for leaks. If no leaks are found, evacuate the low side. For the hot gas valve, pressurize the refrigeration system and test for leaks If no leaks are found, evacuate the system.
5. Install the access panels.
6. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil. Add as required. For the hot gas valve, recharge the unit with proper refrigerant.

Liquid Return Check Valve Repair

Removal

1. Pump down the low side and equalize pressure to slightly positive.
2. Remove the access panels.
3. Remove the cap nut from the check valve and remove the spring and seat.



1.	Cap
2.	Gasket
3.	Spring
4.	Seat
5.	Body

Figure 79: Check Valve with Cap Nut

Installation

1. Inspect the inside of the check valve body for damage or foreign particles that might adhere to the seat and damage the new seat. If the body is damaged, replace the check valve.
2. Install the new seat and spring. Place a new gasket on the cap and tighten the cap nut.
3. Pressurize the low side and test for leaks.
4. If no leaks are found, evacuate the low side.
5. Install the access panels.
6. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Liquid Return Valve Replacement

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the access panels.
3. Unsolder the lines and remove the check valve.

   NOTE: Disassemble the valve before unsoldering.

Installation

1. Clean the tubes for soldering.
2. Place the disassembled check valve in position. The arrow on the valve body indicates the direction of refrigerant flow through the valve.
3. Solder the inlet and outlet connections. After the valve cools, reassemble the valve.
4. Pressurize the low side and test for leaks.
5. If no leaks are found, evacuate the low side.
6. Install the access panels.
7. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil.

Heat Exchanger

Removal

1. Pump down the low side and equalize the pressure to slightly positive.
2. Remove the access panels.
3. Remove the mounting hardware used to mount heat exchanger to the panel.
4. Unsolder the refrigeration lines from the heat exchanger ports and remove it from the unit.

CAUTION: Use a heat sink to prevent damage to nearby valves.

Installation

1. Clean the tubes for soldering.
2. Position the tubes in the proper ports on the heat exchanger.
3. Reinstall the mounting hardware used to mount heat exchanger to the panel.
4. Solder the refrigeration lines from the heat exchanger ports to the tubes.

CAUTION: Use a heat sink to prevent damage to nearby valves.

5. Pressurize the refrigeration system and test for leaks.
6. If no leaks are found, evacuate the low side.
7. Install the access panels.
8. Open the refrigeration valves and run the unit. Check the refrigerant charge and compressor oil. Add as required.

Remote Evaporator Structural Maintenance

Unit Inspection

Inspect the unit during the unit pretrip inspection and scheduled maintenance inspections for loose or broken wires or hardware, compressor oil leaks, or other physical damage which might affect unit performance and require repair or replacement of parts.

Defrost Drains

Clean the defrost drains during scheduled maintenance inspections to make sure the lines remain open.

Evaporator Coil

Clean the evaporator coil during scheduled maintenance inspections by blowing compressed air from the top side of the coil down toward the bottom (the direction opposite the normal air flow). Inspect the coil and fins for damage, and repair if necessary.

CAUTION: Air pressure should not be high enough to damage the coil fins.

Remote Evaporator System Diagnosis

Condition	Possible Cause	Remedy
Load temperature too high	Refrigerant shortage	Repair leak and recharge
	Setpoint too high	Adjust setpoint
	Expansion valve plugged	Clean or replace
	Partial obstruction in low side of refrigeration system	Locate obstruction and repair
	Iced or dirty evaporator coil	Defrost or clean evaporator coil
	Expansion valve open too much	Replace or adjust valve
	Poor fitting trailer door	Repair or replace doors
	Liquid line solenoid partially closed or defective	Repair or replace
	Evaporator fan not operating	Check and correct evaporator fan
Evaporator fan motor does not run	Fuse F12 blown	Check for short circuit in unit wiring and replace fuse
	Open in FM circuit	Locate open and repair
	Defective fan relay	Replace fan relay
	Defective fan motor	Replace fan motor

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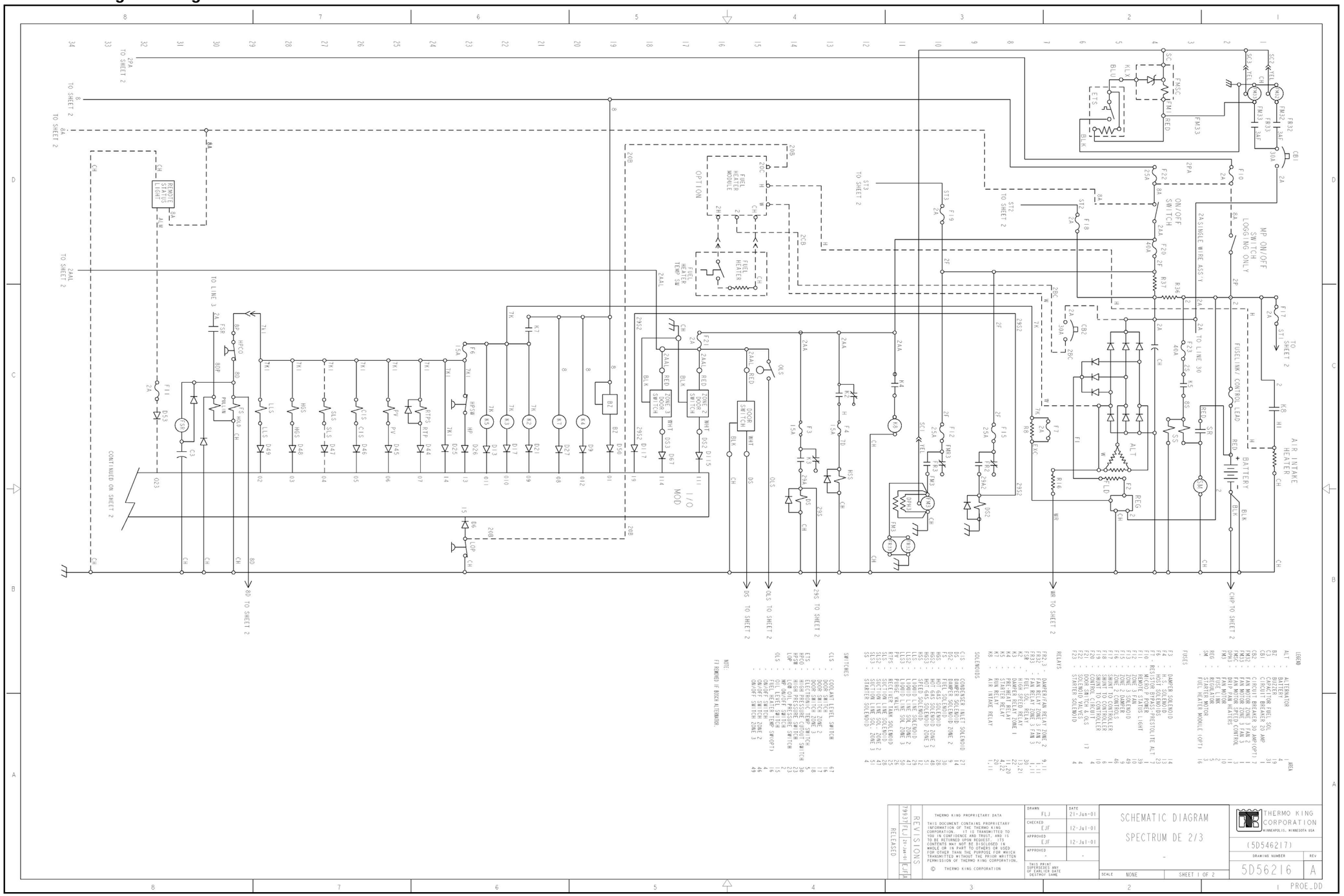

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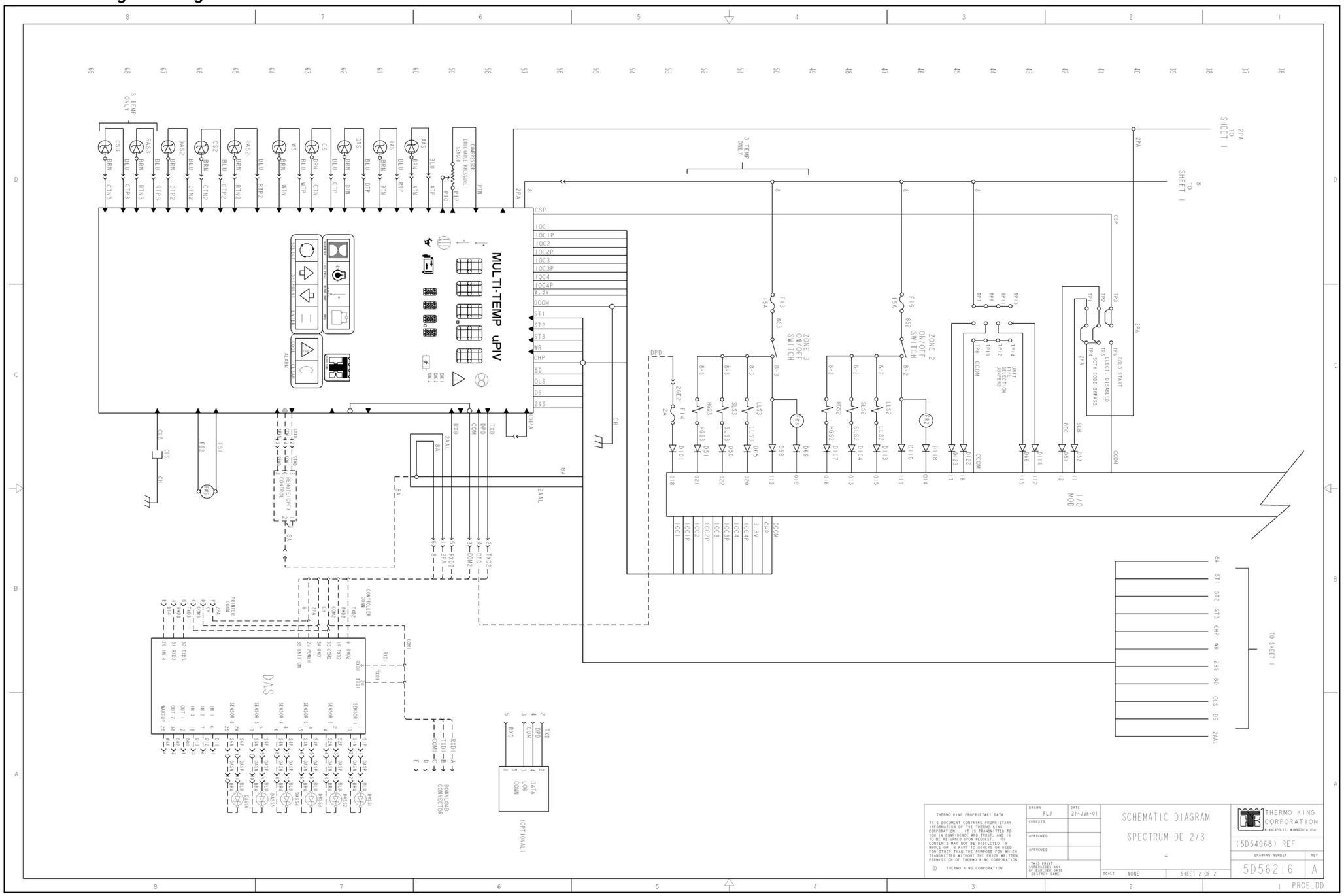

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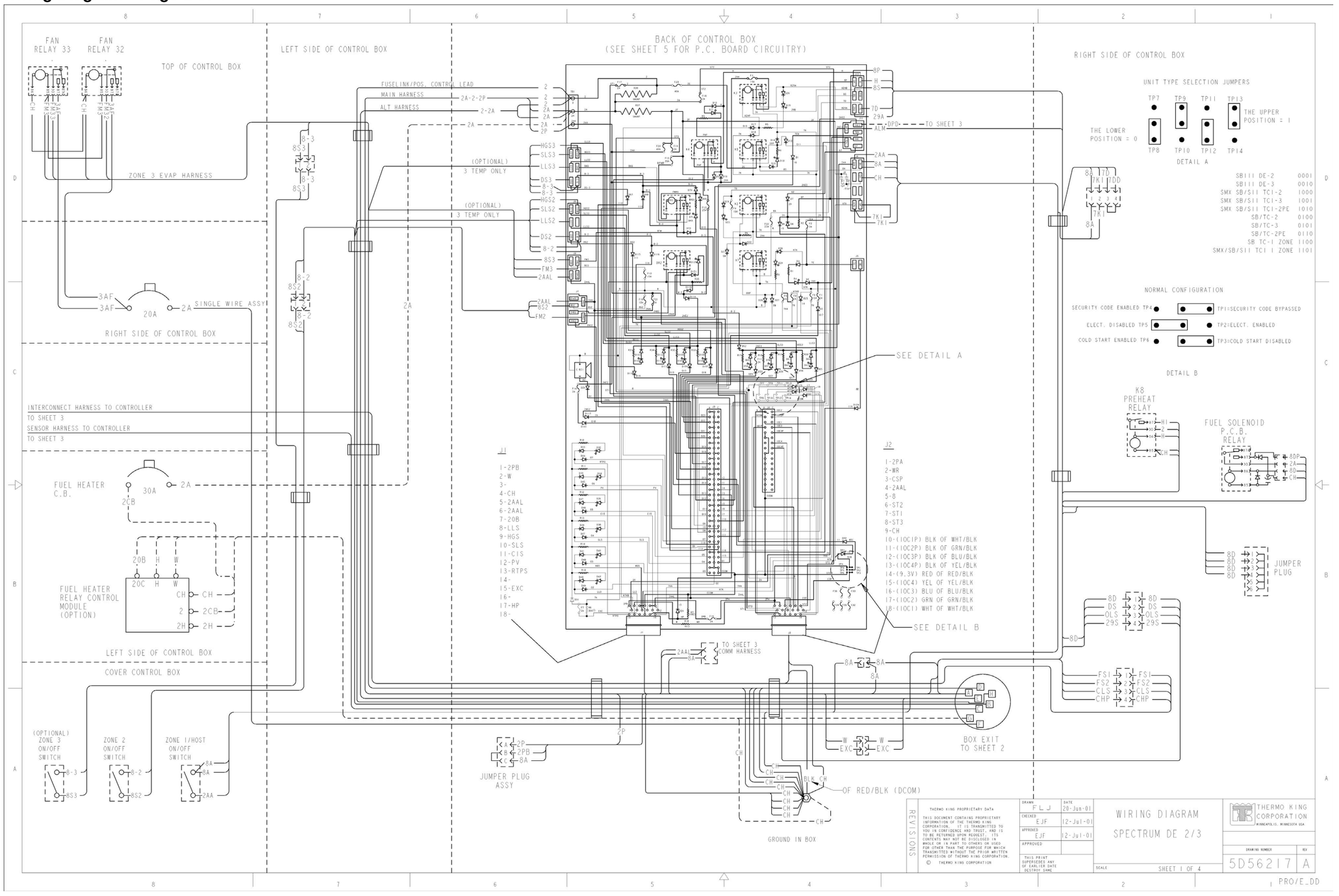

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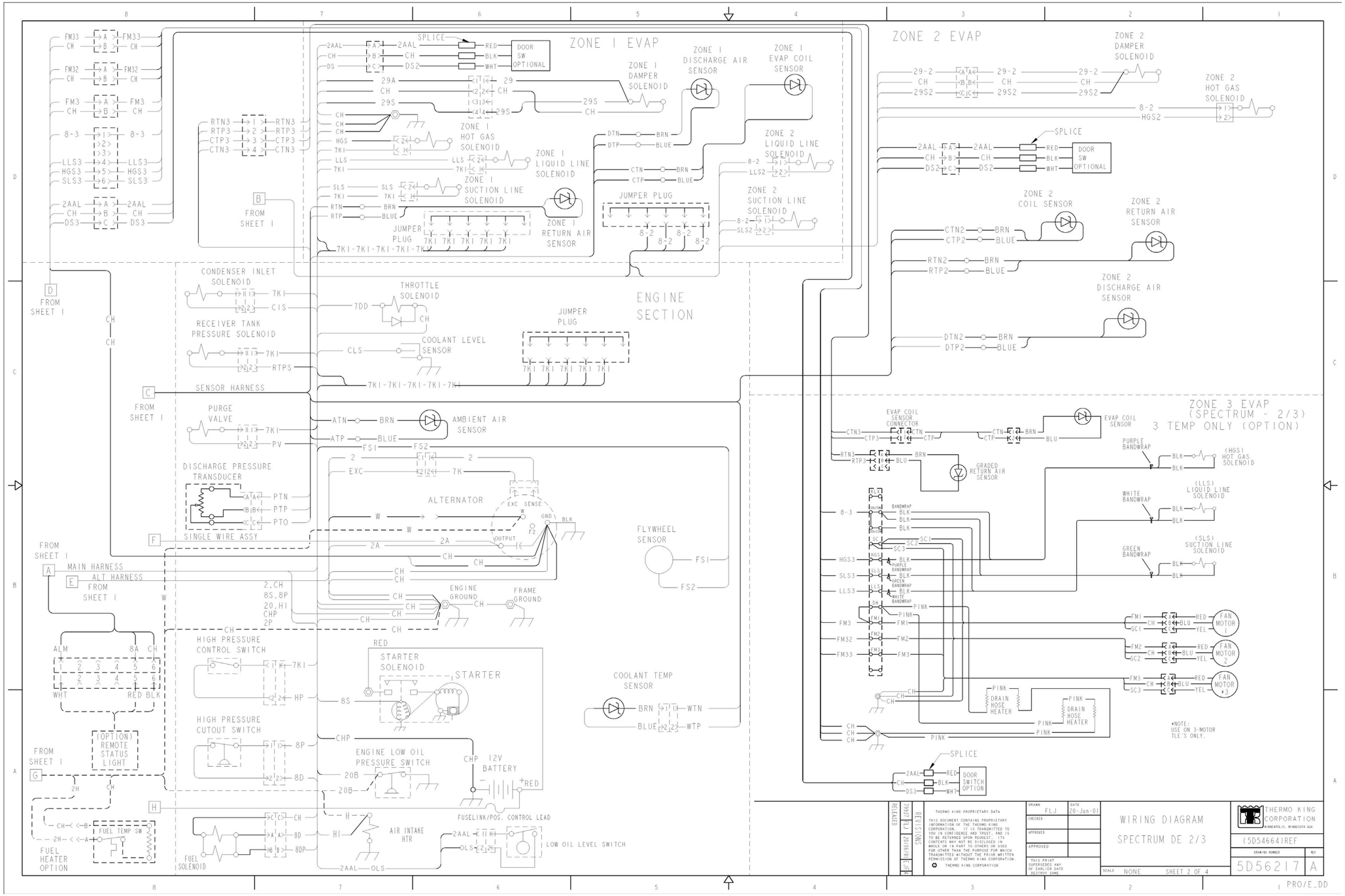

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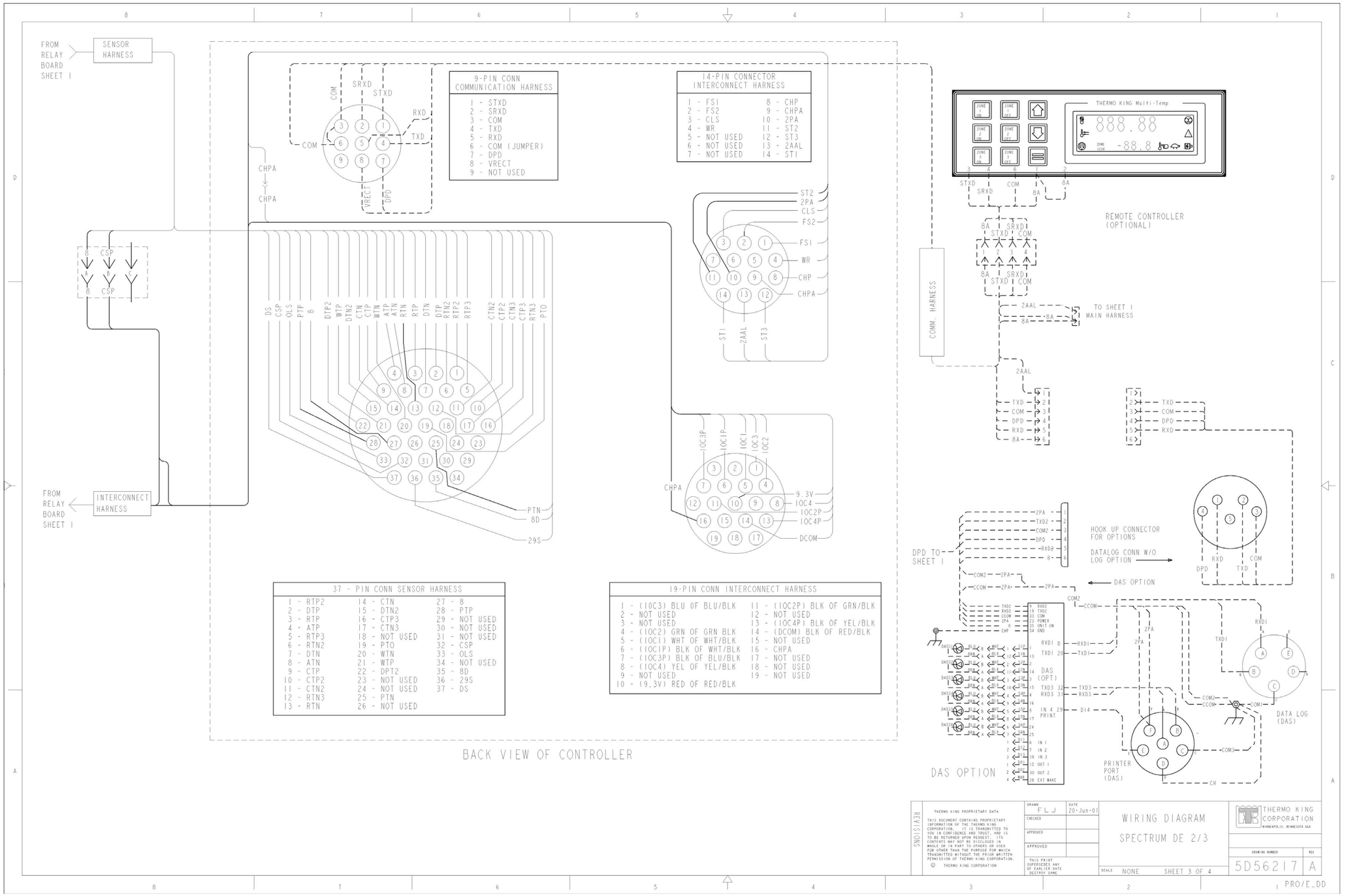

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